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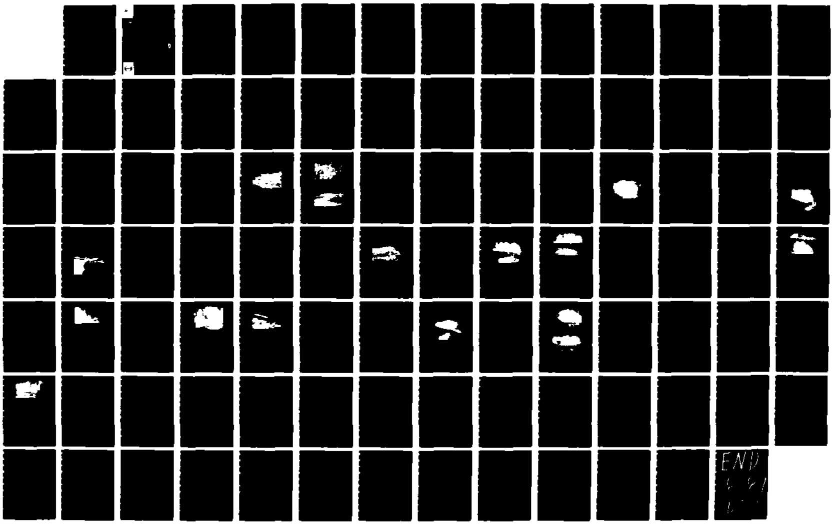

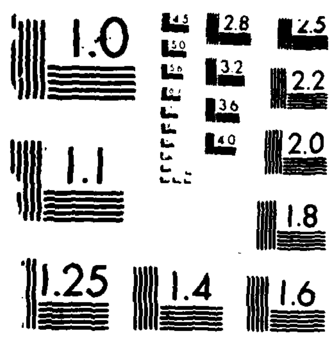

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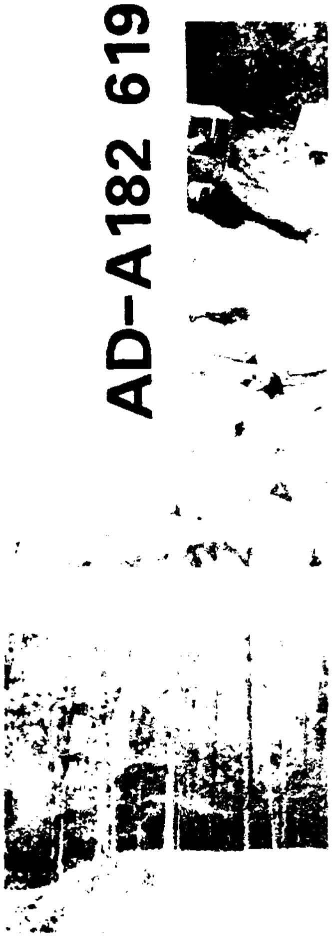

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ARCHAEOLOGICAL SITE PRESERVATION TECHNIQUES: A PRELIMINARY REVIEW

by

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Archaeological site preservation as a practice is a newly emerging field. Combining a variety of civil engineering techniques with a knowledge of the characteristics of archaeological properties, archaeological site preservation may be said to be in its infancy. Research on site preservation technology was conducted by means of a questionnaire sent to over 400 archaeologists and cultural resource managers in the Federal Service. Responses indicated several overriding factors. Most respondents had not actually been involved in site preservation activities. Those who had been so involved reported that whatever preservation actions had been taken were, for the most part, unpublished and had not subsequently been evaluated as to effectiveness. Impacts to sites were numerous and could be subdivided into natural forces (such as frost action, erosion of various types, and faunal activity) and human actions. The latter includes numerous activities associated with land use and development plus intentional vandalism.

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19. ABSTRACT (Continued).

The scope of this report includes a review of techniques that have been employed in attempts to preserve and protect archaeological sites. Divided into techniques termed "natural" and "man-made" which have been applied to site situations termed "horizontal" and "vertical," a total of 29 methods are described. Ranging from earth burial and other vandal prevention devices to natural and man-made camouflage and stream control structures, the techniques described provide an initial summary of the technology currently available in archaeological site preservation and protection.

SUMMARY

This summary statement will seek to integrate two closely related but not identical intellectual endeavors. The first of these consists of the philosophical body of thought that underlies the development of public archaeology in this country, including the necessary mitigation or rescue archaeology that has been associated with that development. The second focus is the embodiment of these principles within our Historic Preservation legislation and, more specifically, within the relevant cultural resources regulations of the US Army Corps of Engineers. The purpose herein is not to provide specific guidance to individual Corps archaeologists coping with problems at specific sites, but rather to integrate at a higher level of abstraction our Historic Preservation goals with the legislative and regulatory mandates within which we must operate.

Conservation of archaeological resources is a relatively new concept in American archaeology. Whereas site preservation has been recognized to lie within the public interest since passage of the Antiquities Act of 1906, and thus part of the mission of the Corps of Engineers, it has only been within the past decade that conservation has become increasingly a focus of attention (Lipe 1974). The principles espoused by Lipe and the American Society for Conservation Archaeology, which represent the point of view of a significant portion of the professional archaeological community, are that archaeological resources are finite and fragile, and their wise use in the public interest must include their protection and preservation. Lipe argued for a reduction in site exploitation via excavation which, although yielding new information, simultaneously results in the destruction of the site. Instead, in Lipe's view, excavation is to be considered as the logical last step in archaeological site use rather than the primary focus of archaeological inquiry. This new focus stresses site inventory as the first step, followed by site evaluation, protection, and preservation, with excavation being the chosen alternative only in those cases where the site is threatened with destruction by an outside agent. In the latter instance, excavation and recovery of the scientific information are deemed mitigation of the projected impacts. From this conservation viewpoint, site preservation becomes the preferred alternative in archaeological site management.

As well intended as these theoretical constructs may have been, they have been largely ignored. The last decade has witnessed instead a burgeoning growth in site mitigation through excavation. We have had the passage of more protective legislation, the Environmental Impact review mechanism established, and the mobilization of hundreds of "contract" archaeologists. Federal agencies have responded by staffing with archaeologists to "manage" the cultural resources. Most of this management consisted of cultural resource inventories of those areas to be altered by a construction project, with sites to be directly impacted often slated for excavation. A "boom" in contract archaeology ensued, which climaxed in 1981 and then declined due to the world oil surplus, cutbacks in energy development, and reductions in water resources development. Reports at the height of this activity estimated that total public funding of contract archaeology was between $100 and $200 million per year. Yet the overwhelming majority of this activity was focused on site discovery and excavation rather than on site preservation in situ.

Site Avoidance

A primary reason for the lack of focus on site preservation techniques is the belief that site avoidance constitutes site preservation. After the inventory stage of a project, sites are evaluated, with those of significance being avoided whenever possible. Project designs are modified, with the right-of-way being shifted, the reservoir level changed, an alternative dam site chosen, etc., in order to avoid directly impacting sites. In smaller projects such as oil well drilling pads and transmission pipelines, shifting of the impact zone often results in all sites being avoided so that no excavation is necessary. What is not considered is the fact that primary impact avoidance does not, and cannot, in itself guarantee the continued unaltered existence of the site. For example, construction of a well site and pipeline access roads increases the traffic to previously remote locations and therefore increases the possibility of site vandalism, a potential secondary impact. Whereas site avoidance is considered a standard method to achieve site preservation, such a conclusion is not warranted because of erosion and other continuing processes of degradation. In addition, since project areas are seldom revisited after completion of the project or at least site

condition is not specifically reevaluated, site avoidance as site preservation becomes a circularly reasoned and untested assumption. Further, with the lack of focus on site preservation methodologies, those few projects in which site preservation methods were employed usually did not feature publication of the methods attempted nor monitoring of the success of those methods over time. It is hoped that current continuing studies will yield such information in the future. As a consequence, there is only a limited quantity of literature on site preservation techniques, with the exception of attempts to stabilize Southwestern masonry and adobe structures. We have no summary available of preservation methods attempted, or evaluation of their relative success. It is with the purpose of filling this gap that this report is presented.

The questions to be resolved include what types of threats to sites exist on a continuing basis. Erosion and vandalism are immediately apparent, but long-term processes such as ground-water fluctuations, organic decay, subsidence, acid rain, and application of pesticides can also alter the chemical and stratigraphic components of sites in ways that are largely unknown. Many of these questions were initially studied during the National Reservoir Inundation Study. However, many of those experiments could not be completed, and many questions remain unanswered.

A second question concerns the types of protective mechanisms that have been employed. We need to know, as a part of standard archaeological practice, what these methods are and how they may be used. Further, we need evaluative studies to determine how successful they have been. Finally, we need to develop, after the methodology, theory. We need hypotheses to be tested and models of the site modification processes, how they work, as well as management alternatives--how we can segregate sites for treatment.

This report grew out of two activities initiated by Corps personnel. The first was a planning workshop in St. Louis, Mo., 29 July to 1 August 1984, which involved Corps archaeologists and personnel from other agencies. The second consisted of a questionnaire mailed to Federal agency archaeologists and cultural resource managers. Both of these efforts were structured to elicit information about and attitudes toward archaeological site preservation activities. In addition, follow-up discussions were held during the 1985 Society for American Archaeology meetings in Denver, Colo. These efforts revealed that much more was being accomplished in site preservation than had

previously been suspected, owing primarily to the fact that most preservation activities were not being reported in the archaeological literature.

These efforts were undertaken in support of the mission of the Corps of Engineers to preserve archaeological sites as specified in Federal historic preservation laws and regulations. This relevant law and policy is discussed below to make clear the requirements under which the Corps is to conduct site preservation activities.

General policy is expressed in the National Historic Preservation Act (NHPA) of 1966 (Public Law 89-665), as amended. Section 110 (a)(1) of that act states: "The heads of all Federal agencies shall assume responsibility for the preservation of historic properties which are owned or controlled by such agency," and "(g) Each Federal agency may include the costs of preservation activities of such agency under this act as eligible project costs in all undertakings of such agency or assisted by such agency." As a follow-up to these general legal requirements, the Advisory Council on Historic Preservation (ACHP) has elucidated in a handbook a series of guidelines concerning the treatment of archaeological properties. These are as follows: "Principle I: Archeological research, addressing significant questions about the past, is in the public interest," and "Principle VII: If an archeological property can be practically preserved in place, it should be...Accordingly, it is appropriate to preserve in place as large a range of archeological properties as possible, even if we cannot define precisely how we would use the information they contain. There are obvious practical limits to application of this principle, but as a rule, if an archeological property can practically be left in place and preserved from damage, it should be" (ACHP Handbook, pp 237-243).

Specific authority for the Corps to engage in any archaeological activities in conjunction with its other responsibilities is contained within the Reservoir Salvage Act of 1960, as amended in 1974 (Public Law 93-291). Section 3(a) of that act states:

> Whenever any Federal agency finds, or is notified, in writing, by an appropriate historical or archeological authority, that its activities in connection with any Federal construction project or federally licensed project, activity, or program may cause irreparable loss or destruction of significant scientific, prehistorical, historical, or archeological data, such agency shall notify

> the Secretary, in writing; and shall provide the Secretary with appropriate information concerning the project, program, or activity. Such agency may request the Secretary to undertake the recovery, protection, and preservation of such data (including preliminary survey or other investigation as needed, and analysis and publication of the reports resulting from such investigation), or it may, with funds appropriated for such project, program, or activity, undertake such activities.

Under the terms of that act, up to 1 percent of the appropriated construction monies may be used for such activities. Specific funding authority is presented in Public Laws 96-95 and 96-515.

Preservation of sites as a management option is further sanctioned in Corps regulations (Engineer Regulation (ER) 1105-2-50, 29 January 1982, paragraph 3-4) as follows:

> a. Historic properties are finite, nonrenewable resources that must be taken into account in formulating recommendations for project authorization and implementation pursuant to the NHPA and implementing regulations of the National Park Service and the Advisory Council on Historic Preservation when such resources are included in or determined to be eligible for inclusion in the National Register of Historic Places.
>
> b. Preservation of significant historic properties through avoidance of effects is preferable to any other form of mitigation. During the planning process, alternative solutions shall be sought to water resource problems that avoid effects on properties that are either listed or eligible for listing in the National Register, and when such properties can be preserved, full consideration shall be given to this course of action. Those actions having an unavoidable effect on National Register or eligible historic properties shall be fully coordinated with the appropriate State Historic Preservation Officer and the ACHP in accordance with 36 CFR Part 800.
>
> c. Reports or other information made available to the general public shall not contain specific locations of archaeological sites so as to preclude vandalism.

More recently, this policy has been further articulated in a draft engineer regulation (ER 1130-2-XXX). This document states:

> 4. Definitions.
>
> b. "Historic preservation" refers to identification, evaluation, recordation, documentation, report preparation, curation, acquisition, protection, management, renovation, restoration, stabilization, maintenance, and reconstruction, or any combination of the foregoing activities, in relation to historic properties.

6. Policy.

a. The Congress and the President as expressed through various statutes and administrative actions, have declared that the protection of historic properties is in the broad public interest. Therefore it is the policy of the Chief of Engineers to identify, evaluate, protect, preserve and manage significant historic properties located on Civil Works Water Resource projects.

b. Historic preservation is an equal and integral component of resource management at operating Civil Works projects. As such, historic preservation shall be given just and equal consideration along with other resource objectives in preparation and implementation of Master Plan and Operation Management Plan documents. It is the responsibility of all Corps elements to coordinate the historic preservation activities outlined in this and other regulations.

17. Funding Authority.

a. Authority for funding archeological work is found in 16 U.S.C. 469, The Reservoir Salvage Act, as amended. For completed Corps of Engineers projects the one-percent limitation on the authority to conduct archeological investigations has been waived by the Secretary of Interior. One-percent has been interpreted to be equal to one-percent of the original project cost, and may include annual O&M costs to date. The procedures for obtaining waivers or increased funding authority for projects under construction or in design will follow procedures outlined in ER 1105-2-50.

Policy Summary

The overall policy of the Corps of Engineers with respect to the preservation of cultural properties can be summarized as follows:

a. The information contained within such cultural properties lies within the public interest as defined by legislation.

b. The Corps has responsibility for the cultural properties on the lands it owns or manages.

c. The preservation of cultural information in situ is an alternative management option to data recovery through excavation.

d. Costs of such preservation activities are specifically authorized by legislation and regulations.

e. Such cultural properties to be preserved should be "significant," i.e., listed on the National Register of Historic Places or "eligible" for such listing.

Thus far, two somewhat contradictory lines of thought have been developed. The first is that, to date, site avoidance has been the primary site preservation alternative pursued, with data recovery through excavation the primary mitigation procedure being employed in most cases. The second is that site preservation is in fact a major responsibility which deserves much effort to devise and test methods that will preserve and protect cultural resources in place. Such preservation activities are not only sanctioned by statute and regulations but are preferable to excavation. However, full realization of the benefits to accrue from site preservation is severely constrained by a lack of information, technology, and proven methodologies. This situation has led directly to the development of the present program in site preservation research based at the US Army Engineer Waterways Experiment Station. This report, the first step in this program, is a review of known techniques which have been attempted in site preservation.

Future activities within this program will include research on and testing of new techniques which may be applied in the protection and preservation of cultural properties. These technical tools, when they become available, will give decision-makers within the Corps of Engineers more management options and flexibility in the future treatment of cultural resources.

PREFACE

The information compiled in this report was collected under Work Unit 32357, Field Preservation of Cultural Sites, of the Environmental Impact Research Program (EIRP). The EIRP is sponsored by the Office, Chief of Engineers (OCE), US Army, and is assigned to the US Army Engineer Waterways Experiment Station (WES) under the purview of the Environmental Laboratory (EL). Technical Monitors were Dr. John Bushman and Mr. Earl Eiker of OCE and Mr. Dave Mathis of the US Army Engineer Water Resources Support Center. Dr. Roger T. Saucier, EL, was the Program Manager of the EIRP.

The work was performed at the Center for Archaeological Research, University of Mississippi, University, Miss., under Contract No. DACW39-85-M-2002. Dr. Robert M. Thorne served as principal investigator. The original manuscript was prepared by Dr. Thorne and Patricia M. Fay. Dr. James J. Hester, WES, reviewed the manuscript, prepared the summary, assembled the illustrations, and compiled the summary table. This work was performed in the Water Resources Engineering Group (WREG), Environmental Engineering Division (EED), EL, WES. Dr. Hester was employed in the WREG under an Intergovernmental Personnel Act agreement with the University of Colorado. Technical reviewers were Dr. Hester Davis, Arkansas Archeological Survey; Dr. Robert Maslowski, US Army Engineer District, Huntington, Huntington, W. Va.; and Dr. Leslie Wildesen, Colorado Historical Society. The report was edited by Ms. Jessica S. Ruff of the WES Information Products Division.

The study was conducted under the supervision of Mr. F. Douglas Shields, WREG, and Dr. Michael R. Palermo, Chief, WREG; and under the general supervision of Dr. Raymond L. Montgomery, Chief, EED, and Dr. John Harrison, Chief, EL.

COL Dwayne G. Lee, CE, is Commander and Director of WES. Dr. Robert W. Whalin is Technical Director.

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Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

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feet	0.3048	metres
inches	2.54	centimetres
pounds (mass)	0.4535924	kilograms
tons (2,000 pounds, mass)	0.90909	metric tons

ARCHAEOLOGICAL SITE PRESERVATION TECHNIQUES: A PRELIMINARY REVIEW

PART I: INTRODUCTION

Background

1. In Section 2 of the Archaeological Resources Protection Act of 1979 (Public Law (PL) 96-95) the Congress of the United States indicated that archaeological resources on public lands are an irreplaceable part of the Nation's heritage. Section 110.(2) was added in 1980 indicating that

> The heads of all Federal agencies shall assume responsibility for the preservation of historic properties which are owned or controlled by such an agency...Each agency shall undertake, consistent with the preservation of such properties and the mission of the agency and the professional standards established pursuant to Section 101(f), any preservation, as may be necessary to carry out this section (US Government Printing Office 1980).

2. Legislative recognition of the value of our cultural resources, in the form of archaeological sites and standing structures, dates to the passage of the Antiquities Act of 1906. More recent legislation has, however, had a greater impact on preservation and conservation efforts and includes the Historic Sites Act of 1935, the Reservoir Salvage Act of 1960 (PL 86-523), the National Historic Preservation Act of 1966 (PL 89-665 as amended), the Archaeological and Historic Preservation Act of 1974 (PL 93-291) and the Archaeological Resources Protection Act of 1979 (PL 96-95). Public Law 93-291 authorizes Federal agencies to expend a sum equal to 1 percent of the funds appropriated for a project on the cultural resources that are to be impacted by that project. Mitigation by means of excavation has become the standard archaeological resource management alternative associated with new construction. Actually, mitigation is what is authorized by PL 93-291.

3. Almost inevitably, the mitigation process for archaeological properties is considered to equate with either avoidance or excavation. Such a view unfortunately neglects stabilization and preservation of such properties as a viable and frequently desirable first choice. Lipe (1974) recognized the need for a conservation ethic and, more recently, the Tennessee Valley Authority

(TVA) has initiated a program of experimental archaeological site stabilization and preservation (Thorne 1985). The TVA program is ongoing in the sense that stabilization procedures that have been recently put in place are being monitored so that their effectiveness can be ascertained. Monitoring on a regular basis is and must be an important element in the evaluation of site stabilization and conservation.

Scope of the Problem

4. All cultural resource properties are subject to the natural aging process. Because the process is imperceptible in many cases, it is rarely perceived to be a problem with archaeological properties. Activities that alter the land surface are the most visible mechanisms for site disturbance and seem to dictate the instances in which a property must be protected. Not all cultural resource properties that must be managed are being impacted or are likely to be directly impacted by a construction effort, but the properties may still be in jeopardy. Annual fluctuations of water level in man-made lakes take a terrific toll on shoreline sites. Hydropower fluctuations accelerate natural fluctuations, to add to the problem. Historic period changes in forestation patterns, land clearing for agricultural and pastoral purposes, and a wide variety of construction efforts have drastically altered surface water runoff patterns. As a consequence, erosion has become a major destructive force to be considered. Because of the extent of man's intrusion into the natural environment, it is virtually impossible to distinguish between natural and culturally enhanced erosion. Regardless of the stimulus, erosional forces are a major threat to cultural resources which must be countered in a management program.

5. Vandalism of archaeological sites and other cultural resources is in some ways (since these are intentional acts) more destructive of our resources than forces of natural origin. Destructive behavior, particularly by artifact collectors, is repetitive and very difficult to counter. People who collect and deal in artifacts follow an avocation that is difficult to deter, even in the face of possible civil or criminal prosecution.

6. Support documentation for this paper was solicited from resource managers from across the Nation by means of a questionnaire. The respondent was asked to identify the different causes of site destruction. While the

responses were heavily weighted toward construction-related impacts, agricultural practices, and vandalism of various kinds, a surprising number of other forces were identified. Many were specific to particular geographical or topographical regions while others could be expected to occur on a broader basis. Among the former are frost heave (Alaska), volcanic activity (California), and brush chaining (Arizona), while the latter included bioturbation, alluviation/colluviation, and living history reenactments. Responses to the questionnaire are compiled in Appendix A. The listing of modes of site destruction identifies activities/actions that resource managers should bear in mind. This report will not address all of the identified impacts and potential solutions since many of the forces inherent in the destructive mechanisms are poorly understood or beyond the control of resource managers.

Approaches to Site Preservation

7. Stabilization techniques that are appropriate for holding streambanks in place may also be appropriate for the preservation of archaeological sites. However, archaeological site stabilization has the added dimension of the presence of culturally specific elements which must be carefully considered in selecting a stabilization technique for a specific site. In every case of planned stabilization, care must be exercised so that the treatment and cure are not more destructive than the problem being addressed. An understanding of archaeological sites and their potential contents is necessary before any stabilizing measures are implemented. Potential impacts on site elements must also be understood, i.e., the manager should be aware of potentially destructive chemical changes, weight and/or pressure changes, or runoff and erosional pattern alteration.

Organization of the Report

8. In the sections that follow, a distinction is made between horizontal stabilization needs and those which are of a vertical nature. This dichotomy essentially divides sites into groups made up of those that are not exposed in a streambank or shoreline cut bank and those that are. While the forces that act on these two classes of loci are essentially the same, the degree of severity is likely to be very different. No single stabilization

technique can be recommended as best for a specific site or situation. The topographic and climatic variability of the 50 States precludes any effort to rank the various techniques. Herein, the approach is taken that site loss as a result of some construction effort is being handled through one of the mandated procedures, and the techniques presented should be useful in that planning process. Further, the view is taken that erosion will ultimately be the mechanism that removes most cultural deposits. Those human activities that are intermediate between a site's condition of being undisturbed and its condition of being destroyed are agents whose effects must be lessened or removed if the forces of erosion are to be negated. Specific plant species to be used are not recommended. However, certain long-term preservation problems that could arise if the wrong species are selected are identified. In-place costs of the various techniques are not provided, although the cost items that must be considered are mentioned.

9. Ways in which resource managers have addressed vandalism are also discussed. Thoughtless acts combined with the effects of time have often led to considerable site damage. Preservation efforts to correct these problems range from partial or complete reconstruction of the resource to preservation of the resource in an "as is" condition.

10. The issues of conserving standing structures are not addressed since the focus of this guide is on archaeological sites within a soil matrix. We would point out, however, that some standing structures have been "preserved" by moving them or tearing them down and salvaging usable parts. Some have been raised, and the sills and joists repaired and placed on new and improved foundations. Resource managers are reminded that when a standing structure is of enough import to merit preservation, most assuredly there is an archaeological component that deserves equal treatment. Care should be exercised to ensure that the preservation of the one does not cause or hasten the destruction of the other.

11. A number of agency representatives have reported that avoidance was a primary measure used to lessen construction-related impacts to a resource. Fiscal parameters certainly argue in favor of avoiding a site or structure, as does the hope that the resource will somehow survive on its own. Such an approach frequently begs or avoids the issue and, while direct construction-related damage or destruction may be avoided, resources too frequently are inadvertently damaged or destroyed. Even though the loss may be described as

accidental, an irreplaceable resource is nevertheless gone. Resource destruction can and does occur after construction has been completed and frequently can be shown to be a result of how or why a particular project was used. Such destruction is frequently described as the result of an indirect or secondary impact.

12. While many archaeological properties share common features, each is different from all others. The idiosyncratic nature of each property dictates that the uniqueness of that resource be considered. A conscious effort must be made to resist any tendency to group properties that seem to share common characteristics and apply across-the-board solutions to "common" problems. To do so would be to ignore the singular quality of individual properties. It is the responsibility of the resource manager, whether having archaeological training or not, to become acquainted with the resources to be protected and to seek out specific information as to what the appropriate means of protection should be. In those cases where resource management is the responsibility of professionals trained in areas other than archaeology or cultural resource management, they should make an effort to meet and cultivate the interests of a willing support or advisory group.

13. Before stabilization efforts are attempted, professional resource management input must be solicited so that an informed preservation approach can be designed. Not all properties are suitable for, require, or merit preservation and the attendant expenditure of effort and funds. Decisions regarding the significance of cultural resources should be made by a professional (prehistoric or historic archaeologist, architectural historian, historian, or anthropologist), who can then work with professionals in other areas to ensure that the most appropriate means of preservation is selected.

14. The preservation measures presented here should be considered a descriptive guide to the various alternatives that are available. Most are techniques that have been reported to have been attempted in an effort to preserve cultural resource properties. Many are unreported in the archaeological literature, and few have been monitored to ascertain the effectiveness of the technique. It is incumbent upon every resource manager to describe preservation efforts to ensure that other managers are kept informed of successes and failures. It is equally incumbent upon resource managers to know what individuals and agencies are locally available to advise them in selecting preservation techniques. As indicated above, this report does not

make specific recommendations. Rather, it is stressed that site preservation efforts are in their infancy and archaeologists and cultural resource managers can profit from all available information. In that regard, many state and Federal agencies maintain conservationists who can aid in preservation efforts.

PART II: PRESERVATION TECHNIQUES

15. The preservation of archaeological properties has a relatively long history in the United States, beginning with the Marietta Mound group in Ohio in 1788 (Thorne 1985). In subsequent years, justification for the selection of one technique over another appears to have been largely intuitive, and that pattern has continued to the present. Streambank stabilization procedures have been adapted for archaeological application with apparently little thought being given to the impact that the stabilization technique might have on the artifacts that are the focus of the preservation effort. From this perspective, managers must remember that site contents may be made of bone, stone, shell, wood or wood products (charcoal), and clay as well as the less tangible remains of rotted organics left by the original population. These include post stains as well as the remains of cache and storage pits and occasionally their contents. If friable artifacts of this kind are to be protected in a form close to the original, care must be exercised in selecting the proper preservation method.

16. As noted earlier, a questionnaire was used to collect baseline information about techniques that have been used by resource managers to preserve cultural resources. Most of the techniques discussed below were selected from the total range of responses that were received. They are discussed in two broad areas--horizontal and vertical stabilization needs--and within these, according to whether the material to be used is natural or man-made. Additional techniques, termed stream training and pedestrian/vandalism control, are described for use alone or in combination with the horizontal and vertical stabilization measures. Considerations in the use of these techniques are summarized in Table 1.

Horizontal - Natural

Earth burial

17. Burial of archaeological sites was reported as a preservation technique, but its use in most cases was apparently without prior knowledge of what the long-term effects on the property might be. The distinction is made here between sites that have had a relatively thin mantle of soil placed over

Table 1

Summary of Preservation Techniques

Technique	Applications	Factors to be Considered	Advantages	Disadvantages	Cost Factors	References
Horizontal - natural						
Earth burial	Rebuilding mounds; roadfill; concealment	Needs separator filter; fill should be sterile; long-term effects unknown; deep or shallow cover; organics, burials, archaeological soil chemistry compatibility	Retards erosion; could be farmed; used for highway rights-of-way; permits revegetation	Fill must be obtained costs include revegetation	Cost of fill, transportation, placement, filter fabric, sodding or reseeding	Garfinkel and Lister 1983, Thorne 1985, Wilson 1976,
Sand burial	Marker bed to contrast with artifact-bearing matrix; to serve as a permeable filter layer	Must be sterile; must be chemically compatible	Surface reusable	Unstable; erodes easily; high permeability	Cost of sand transportation, placement, sodding or reseeding	Thorne 1985
Stone (riprap) or gravel burial	Streambank erosion; lakeshore erosion	Combined with filter fabric; must prepare surface of ground	Very durable; resists erosion; impedes vandalism; can shift naturally; permits vegetation; permits seepage	Can impact site contents; may require heavy equipment; expensive; can erode between stones	Cost of stone, transportation, placement, filter, and placement	Ramiller and Fredrickson 1983, Thorne 1981
Sodding	A form of site burial; stabilizes surface	Needs ground preparation; avoid species with deep roots; select species native to area	Prevents surface erosion; natural appearance	May require soil mantle as buffer	Cost of sod, placement, and fertilizers, plus any soil used	
Channelization and placement of dredged materials	Along shorelines to cover sites		Could be cost free; provides a sterile pseudo-shore	Cannot be used on steep banks; requires preconstruction planning	Costs may be same as normal disposal costs; includes barging if necessary	Thorne 1985
Backfilling	To stabilize excavated areas; prevent vandalism	Features are first covered with plastic sheeting; need to include some modern cultural markers; fill should be sterile or clearly marked	Prevents erosion; may inhibit vandalism; inexpensive	Use of trucks could damage site; could lead to confused strata	Cost of fill, transportation, and placement, including land filling, and plastic sheeting	Thorne 1985

(Continued)

(Sheet 1 of 5)

Table 1 (Continued)

Technique	Applications	Factors to be Considered	Advantages	Disadvantages	Cost Factors	References
Horizontal - man-made						
Vegetation	Control surface erosion; provide cover	Usually local species; size of root system	Inexpensive; environmentally compatible	Larger species have larger root systems; lateral root growth along features; may need to smooth surface	Cost of surface preparation, planting, and fertilizer	
Continuous concrete slabs	To prevent vandalism	Needs reinforcing wire	Difficult to break through	Prevents scientific access; must first remove vegetation; first need to smooth surface; heavy weight; transport of mix may be difficult and/or damage deposits; may erode under slab	Cost of readymix and transport, wheelbarrow loading and dumping	Thorne 1985
Gunite	To prevent erosion; to prevent vandalism; can be mixed onsite	Can be used in remote locations; can be sprayed to uniform thickness; can be undercut by erosion	Permits access to underlying deposits	Can be eroded; develops cracks	Cost of sand, cement transport, use of spraying equipment, site clearance, and wire reinforcing	Galm 1978
Articulated concrete block mattress	Shoreline banks; along large rivers	Installed from barge; requires bank preparation	Precludes easy access by vandals	Installation can damage site; prevents scientific access; costly to install; revegetation prevented	Cost of blocks and installation; may require causeways or other site protection	
Cellular blocks	Streambank sites to prevent erosion	Placement by hand, one block at a time; ground preparation necessary; requires vehicle access; installed over fabric or gravel filter	Patterned blocks permit revegetation and control erosion	Revegetation prevented; weight can damage site; vandals can remove blocks	Cost of blocks and transport; site preparation, filter cloth, and hand labor	

(Continued)

(Sheet 2 of 5)

Table 1 (Continued)

Technique	Applications	Factors to be Considered	Advantages	Disadvantages	Cost Factors	References
Horizontal - man-made (Cont.)						
Interlocking blocks	Streambank sites or horizontal site deposits	Requires ground preparation; can be filled with sand	Lightweight; chemically inert; permits vegetative growth; can fit over curved surface; resists erosion; difficult to remove		Cost of blocks and transport, site preparation hand placement, and reseeding	Thorne 1985
Asphalt mixes	Can substitute for riprap; site stabilization erosion control	Mixed hot; requires heavy machinery; surface must be prepared; not really recommended	Difficult to break through; could be used underwater; cold mixes could be hand-spread	Installation could damage site; inhibits scientific access; could be undercut; can introduce hydrocarbons	Cost of mix application and compaction	Keown et al. 1977
Soil cement	Streambanks, roadbeds	Requires surface preparation; mixing of upper levels of site;	Relatively durable	Heavy weight of installation equipment; may alter soil chemistry	Cost of cement, mixing, watering, and site preparation	
GEOWEB	Traps silt and sand to cover unstable surfaces	Must be pinned down	May be used under water, if adequately pinned down; prevents erosion; lightweight	May float; easily vandalized	Cost of GEOWEB, shipping, site clearing, hand labor to install, cost of fill	Thorne 1985
Vertical - natural						
Rock berms	Streambanks; erosion control	Requires surface preparation; local stone preferable; vehicle accessibility may require haul road	Durable	Heavy weight; could contaminate cultural deposits with similar quarry material; toe may erode	Cost of rock, site preparation, placement, and filter cloth	
Sandbags and filter cloth	Bank control	Local availability of sand	Inexpensive	Deteriorates as bags weather unless mixture contains cement	Cost of bags, sand, filter cloth, site preparation, and placement	Snethkamp 1983

(Continued)

(Sheet 3 of 5)

Table 1 (Continued)

Technique	Applications	Factors to be Considered	Advantages	Disadvantages	Cost Factors	References
Vertical - natural (Cont.)						
Timber bulkheads and fill	Shoreline stabilization; erosion control	May require installation from a barge; backfill must be sterile; may require plastic film divider; may weather to form new shoreline	Backfill separates cultural material from bulkhead; can use dredged material; may not impact site during installation	Timbers will decay over time	Cost of timber, chemical treatment, installation; barge costs plus crane/dragline fill costs	
Vegetation	Slope stabilization	Bank preparation necessary; hand-planting may require fiber mats; may require copolymer emulsifiers	Aesthetically appealing; flood tolerant; may be part of normal maintenance operation	May erode; may require dirt work	Hand labor; seeds or sprigs; surface preparation	
Vertical - man-made						
Bulkheads	Shoreline sites	Low water level better for installation; may require barge; requires pile driving or air jetting	Backfill isolates cultural fill	Risk of damage during installation; waves may erode base of piling	Costs similar regardless of materials; materials plus installation costs	Keown et al. 1977, Nielson and Keel 1983
Used-tire mattresses	Prevents bank erosion; deters vandals	Surface should be smooth	Inexpensive; permits revegetation	Vandals can stand in the tires to reach cultural deposits	Transportation of tires; labor to install wire rope; transport	Thorne 1985
Gabions	Stabilize vertical banks	Bank may have to be shaped; gabions are filled by hand	Weight of gabions is not on site; durability	Some impact to site may occur; high cost	Cost of gabions, rock fill, hand labor, shipping, and site preparation	Ferguson and Turnbull 1980
Stream training						
Jacks	To reduce streamflow	Requires machinery to install	May be prefabricated; relatively inexpensive	May divert stream to erode bank; installation may damage site; may not work	Cost of jacks, transport, bank preparation, and labor	Keown et al. 1977

(Continued)

(Sheet 4 of 5)

Table 1 (Concluded)

Technique	Applications	Factors to be Considered	Advantages	Disadvantages	Cost Factors	References
Stream training (Cont.)						
Fences	To increase sediment deposition	Local availability of materials	Slows erosion; permits revegetation	May erode bank	Cost of materials and labor	Keown et al. 1977
Dikes	To deflect current; encourage sedimentation and bank stabilization	Type may be permeable or impermeable	Permits revegetation; diverts stream away from site	May be flanked by stream with bank erosion intensified; heavy machinery could damage site	Cost of fill plus use of heavy machinery	Keown et al. 1977
Access control						
Fencing	Control human or animal traffic to avoid site or to avoid impacts to specific areas	Works better in combination with patrolling	Low cost	Can be climbed or cut, thus only partially deters vandals; can advertise presence of site	Cost of fencing, clearing, alignment, and installation	
Signs	Notify public that site is protected - a legal notice; limit access	Best results if combined with patrolling	Low cost	Do not deter determined vandals; advertise presence of site	Cost of signs; labor to install	Thorne 1985
Buried wire mesh	To deter vandals	Must be combined with site burial; compatibility of fill	Effective if vandals are not too determined	Requires fill and may cause site disturbance; can be cut	Costs of wire, labor to install, and earthfill	Thorne 1985
Deadfalls and driftwood facings	To camouflage site; restrict access	Local availability of trees can be combined with land clearing or reforestation	Trap silt; retard erosion; reduce vandalism; permit revegetation; low cost	May float away; short effective life; better methods of bank stabilization are available	Labor plus wire rope and clamps	Henderson and Shields 1984

(Sheet 5 of 5)

them and those that are incorporated in or placed beneath levees or deep road fill. Such a distinction is necessary since the impact of a thin covering as opposed to a thick one would likely be quite different. Site reconstruction may be included as a form of earth burial since the process of rebuilding mounds, etc., would include some of the same potentially destructive elements as complete site coverage.

18. A number of factors must be considered before earth burial is selected as a means of stabilizing a site. Wilson (1976) partially addressed this issue. To ensure that the negative impact on the site is minimized, some prior knowledge of the site's content is necessary. In most cases, a special set of test excavations should not be necessary since site testing was probably carried out prior to the nomination of the site to the National Register. In determining the contents of a site, particular attention should be paid to such elements as the presence of organic remains, human skeletal remains, and architectural features. Ideally, the chemical background of the site should be determined as should the pH of the soil. If there are chemical, soil, or geological constituent differences between features and their surrounding matrix, these differences must also be identified and recorded.

19. Fill material to be used to form the mantle over the site should be chemically compatible with the matrix to be covered, as well as with the artifacts and biofacts within that matrix. Chemical compatibility between fill material to be added to a site and the matrix to be covered is difficult to define. A minimal requirement would be similar soil pH, although other chemical factors may be identified as our knowledge increases. Our lack of knowledge of the effects of fill material on the archaeological matrix makes it essential to specify a one-to-one match. The fact that rather simplistic analytical chemical procedures can provide a distinction between post molds and rodent burrows (in some cases, at least) was reported by van der Merwe and Stein (1972) and is sufficient reason to attempt to maintain chemical stability in the site's original matrix. The task of definition of compatibility is further complicated by the lack of knowledge of the acceptable range of chemical variability within an artifact-bearing matrix that will allow the site's components to be preserved. A further consideration must include a determination of the acidic-basic character of the site, and pH levels should be very similar to ensure that natural decomposition processes are not increased. When possible, quantitative chemical analyses should be completed on both the

original matrix and the fill material. At a minimum, one could have samples analyzed at the level used to determine fertilizer needs. Most state-supported agronomy programs provide this service or a local Soil Conservation Service (SCS) office can provide an appropriate address. The fill material should also be sterile with respect to artifact content to ensure that there is no diachronic mixing of artifactual materials from similar but distinct cultural sequences.

20. To help ensure that separation of the added fill and the original site matrix is readily identifiable, the ideal fill should contrast in color with the artifact-bearing matrix. Where possible, a covering of permeable fabric can be placed over the site as a separator between the cultural deposit and the fill material. (Filter cloth would be ideal; jute bagging could be used, although being organic, it would decay.) The fabric will serve to highlight the division between the site and the fill. Even after the separator has deteriorated, subsequent excavations should immediately pick up the stratigraphic line created at the junction of the fill, the separator fabric, and the site matrix.

21. One function of earth burial should be to retard erosion; therefore, fill material that is not too susceptible to deflation should be selected. At the same time, the fill should be suitable for rapid regeneration of plant cover.

22. When placing the fill, the process should be carefully planned to ensure that the equipment used does not damage the site. In some cases, sufficient fill material might be placed over the site to permit the fill to be farmed.

23. Garfinkel and Lister (1983) have begun to evaluate the effects of deep burial on an archaeological site and its contents. Preliminary results of their study indicate that at least some morphological changes occur in biofacts and artifacts. On the basis of these data, they have begun to develop guidelines for using the earth burial technique.

24. Cost calculations for earth burial must include cost of the fill, its transportation and placement, filter fabric and placement costs, and the sodding or reseeding of the fill material. Professional fees for archaeologists or engineers are generally not considered to be a directly related cost in this or any of the other techniques discussed.

Sand burial

25. Only one survey respondent reported having used sand as fill material for burying an archaeological site. Unless special circumstances dictate that sand be used as fill, other soils would seem to be more appropriate. Problems associated with using sand as an outer mantle material include its instability (which makes it susceptible to aeolian and water erosion) and its permeability (which increases the difficulty of regenerating vegetative cover). If sand is to be used, it should be archaeologically sterile and chemically similar to the artifact matrix. Like earthen fill, a one-to-one chemical pH match between the sand and the archaeological material is recommended.

26. A sand mantle might be appropriate as a marker used to differentiate between an artifact-bearing matrix and similar soil fill. Because of its permeability, the sand layer could serve as a filter to carry off water that permeated an overlying soil layer. Sand, like pea gravel, could effectively serve as a filter beneath a course of riprap. However, unless horizontally contained, the sand could wash out and the riprap could sink into its filter.

27. Cost estimates for burial with sand would include essentially the same elements as earth burial: cost of the sand, its transportation and placement, and sodding or reseeding of the fill material.

28. Both sand and earth burial of archaeological properties have the advantage of leaving the new ground surface available for continued use. Activities which do not disturb the subsurface deposits would be ideal, such as parks, golf courses, etc. The National Park Service covered a site with 12 in.* of fill and then permitted the overburden to be farmed (Thorne 1985). The Park Service included constraints in the lease agreement to ensure that the buried property continues to be protected.

Stone and gravel burial

29. The installation of stone riprap provides a more formidable protective shield than either earth or sand burial. Because of the different requirements for the installation of stone as a protective barrier in horizontal as opposed to vertical positioning, the two approaches will be

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* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 10.

discussed separately here. This section will deal with the covering of a horizontal property.

30. Stone for a covering material may range from gravel to boulder size and can be used in a variety of dimensions and combinations. In some cases, a protective advantage might be gained by combining a stone mantle with filter fabric, sand, or some other filtering material (see Figures 1-3).

Figure 1. Installation of filter fabric, Hurricane Mound, Miss.

31. When considering stone burial as a means of preserving a site, a number of factors must be taken into account. For instance, site content (including both artifacts and organic remains) is a prime subject for attention since the impact of stone burial can be fairly severe. One advantage of large stone is that the weight of the individual pieces is generally heavy enough to resist movement by natural forces, vandals intent on looting, or people who would use the stone for some other purpose. It also has the advantage of being flexible, with individual pieces moving in response to any soil or site settlement. Any damage to the course (or courses) of stone can easily be repaired by addition of new stone. Since riprap is frequently of locally occurring stone, its placement is likely to blend harmoniously with its surroundings. Its loosely joined nature will allow the growth of vegetation through the stones.

Figure 2. Filter fabric and partial riprap covering, Hurricane Mound, Miss.

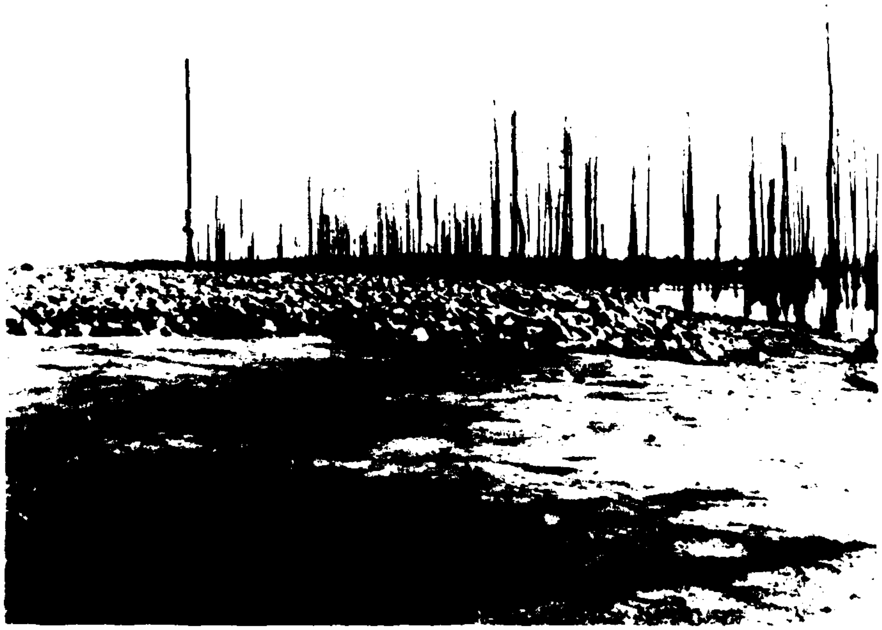

Figure 3. Hurricane Mound, Miss., with riprap in place

32. In some cases it may be necessary to prepare the ground surface prior to placement of the stone. Care should be exercised to ensure that the site is not damaged by the preparation procedures. On steeply sloping banks,

e.g., mound sites, it may prove difficult to maintain a stone covering if a slick-surfaced filter fabric is used as an underliner. Banks of streams that are downcutting are particularly prone to sliding or slipping of the stone. In those instances, a filter layer of gravel would be a better choice than filter cloth.

33. Conversely, the weight of the stone can fracture artifacts or modify the form of features. In some cases, the weight of the stone is such that heavy equipment may be necessary to place it. Placement machinery could be destructive as it moves across the deposit. The potential for destruction can be reduced by using timber mats as travelways for the movement of equipment across the site. Unfortunately, mat placement may require additional equipment, thereby increasing the cost.

34. Concrete rubble can be used in essentially the same manner as stone riprap. Placement of the pieces and use of an underlying filtering material are similar to stone riprap. The effectiveness of concrete rubble may be less than riprap, however, since the blocks of concrete are likely to have several flat faces and sharp and irregularly broken edges. These edges and faces prevent close articulation of the various pieces, leaving large gaps or holes. These gaps may enhance erosion and, if protection from vandalism is the goal, destruction may not be deterred because of the large size of the holes and gaps between the individual pieces. The use of filter cloth or a course of filter gravel may alleviate some of these problems. The irregular nature of the pieces will allow plant growth through the openings at a rate that is likely to be greater than riprap. However, the presence of an underlying tightly woven filter cloth will inhibit grass growth.

35. In using gravel as a burial material, the ideal procedure would be to lay down successive layers of gravel, grading to larger sizes toward the top. This would put the very small grains closest to the small earth particles and the very large-sized gravel on the surface layer. Seepage would be permitted, and very little erosion would take place. Unfortunately, this is labor intensive and expensive. In general practice, the use of gravel involves placement of the stone over a selected area with little regard for size sorting and intentional layering.

36. As noted above, gravel is useful in conjunction with a riprap overlayer, especially on slopes, since the plasticity and small size of the gravel will allow it to be more easily washed away. Gravel as a sole covering

material would be better suited for sites with a level to nearly level topographic configuration.

37. Chemical composition of the stone must also be considered. In the event that the stone is susceptible to water solubility that would lead to chemical or pH soil changes, alternative stone should be sought. However, most stone used for riprap or gravel covering is not likely to weather or break down rapidly enough to alter the chemical/organic composition of the archaeological property.

38. Cost calculations should include the stone, its transporation and placement, filter material (gravel or cloth), and the cost of placing the filtering material. Filter fabrics must be hand-placed and pinned down, and labor costs for this portion of the operation must be included.

Sodding

39. The use of sod to cover a site is essentially a combination of earth burial and revegetation of the site's surface. In most cases, some ground preparation is necessary prior to placement of the sod mats. The ideal circumstances would be to place a thin buffer of culturally sterile soil over the site and place the sod on that. In that manner, any plowing, disking, or harrowing would take place in and on the fill, and disturbance of the cultural deposit would be minimized. The use of sod as a stabilizing mantle over deeper earth burial is an excellent approach.

40. Care should be exercised in the selection of grasses to be used as a sodding agent, avoiding those with deep root systems. Root intrusion can destroy artifacts and biological materials as well as contaminate charcoal. Species selection must be made on a site-specific basis. Grasses suitable for the Eastern United States are obviously not likely to be suited for the High Plains, etc. SCS Conservationists can recommend appropriate grasses and literature that will define the characteristics of each species. The manager must make educated choices based on the region and the specific habitat conditions at the site. In addition to sodding, revegetation can include seeding and sprigging.

41. Cost estimates should include the purchase of the sod and its placement, as well as appropriate fertilizers and rooting hormones if these are necessary. If a mantle of soil is to be used, its cost and that for installation must be included.

Channelization and placement of dredged materials

42. While dredging can cause extensive site destruction, it can also be used as an efficient means of preserving sites. The placement of dredged materials in shallow areas close to the shoreline has become a viable preservation technique. The dredgings make a breakwater which absorbs the force of waves that previously pounded the bank. Some of the archaeological sites that are proving most difficult to preserve are the hidden deposits found along shorelines. This dredged material provides a sterile pseudo-shore which can be eroded instead of the cultural deposit.

43. Problems with the use of dredged materials occur in areas with deep channel cuts close to the bank. In these areas there may be no shelf adjacent to the shoreline to hold the material. Dredgings placed there would fill up the channel cut rather than protecting the site.

44. The use of dredged material as a buffering agent should not increase costs beyond that of normal disposal unless barging over long distances is necessary. Hydraulic dredging would not yield a suitable material to be used in site protection.

Backfilling

45. The backfilling of archaeological excavations has long been practiced by professional archaeologists. Before the introduction of massive waterscreening, fill dirt came from the excavations. All material larger than the screen size being used was removed, but smaller materials were usually haphazardly replaced in the excavation units. When possible, the bottom of most excavations was marked by the inclusion of modern glass artifacts. Backfilling was not undertaken with a futuristic view toward site conservation but usually was the result of an agreement between the archaeologist and the land owner.

46. Recently, when sites have been tested or excavations have been guided by a sampling scheme, backfilling of units has become more systematic. Delineation of excavated units is accomplished by lining the units with polyethylene film prior to filling, with some atypical material being included to mark the bottom of the excavation. Glass continues to be used, but other materials that are out of context with the site's contents (metals, for example) are also included. Gravel and clean sand have also been used as markers.

47. Vandalism by artifact hunters or the potential for soil erosion can lead to a need for backfilling of artifact-bearing strata. In the case where erosion is degrading the site, fill material must usually be brought in from elsewhere. Care should be exercised to ensure that this material is free of artifacts to avoid contaminating the original deposit. Even though sterile fill material is used, something should be used to mark the areas that are backfilled. Filter cloth or polyethylene film will produce a well-defined stratigraphic break and can be clearly discerned in future excavations.

48. Since the fill material will generally be brought in from an area away from the site, care must be exercised to ensure that trucks and other dirt-moving equipment do not damage the undisturbed portions of the site. Fill dirt may have to be stockpiled at the edge of the site and wheelbarrowed to the areas to be filled. Hand-dressing will be necessary in many cases.

49. If holes left by vandals are to be filled with the dirt that was removed, the holes must be marked with glass bottles, some sterile material such as sand or gravel and, when practical, a film of polyethylene should be included. Marking of these holes is necessary since artifact hunters remove only those artifacts that have some aesthetic or cash value. Broken artifacts and organic remains are left behind and, if they are returned to the artifact-bearing matrix in a mixed manner, their presence could lead to erroneous interpretations by future archaeologists. Further, a site map showing areas backfilled should be prepared.

50. When fill material is brought in to a site, it should be chemically similar to the artifact-bearing matrix. Backfilling archaeological properties with earthen fill has the advantage of being relatively inexpensive, even if hand labor must be used. It also will allow revegetation of the site and help it to blend into the surrounding environment.

51. The cost of backfilling sites is dependent upon the source of the fill material. In addition to cost of the fill, transportation and placement should be included in estimates. Hand-filling or dressing will quite likely be necessary and should be included in cost projections. If holes are to be backfilled with dirt that is taken from the excavation, labor will generally be hand work requiring time/labor estimates. Any material (filter fabric or polyethylene film) used to mark the bottom of the areas to be filled must be added to the cost of the project. Polyethelene film will mark the boundaries

of the fill as well as filter fabric and has the advantage of being less costly.

Horizontal - Man-Made

Vegetation

52. Vegetative regrowth has been used frequently as a means of stabilizing and maintaining archaeological properties. The National Park Service often lets nature take its course on sites within its jurisdiction. At some of these, grass growth is held in check by cutting, and woody growth is cut back even further. In most cases, grasses are locally indigenous species rather than introduced weeds (Figure 4). Shrubs and trees are appropriate for

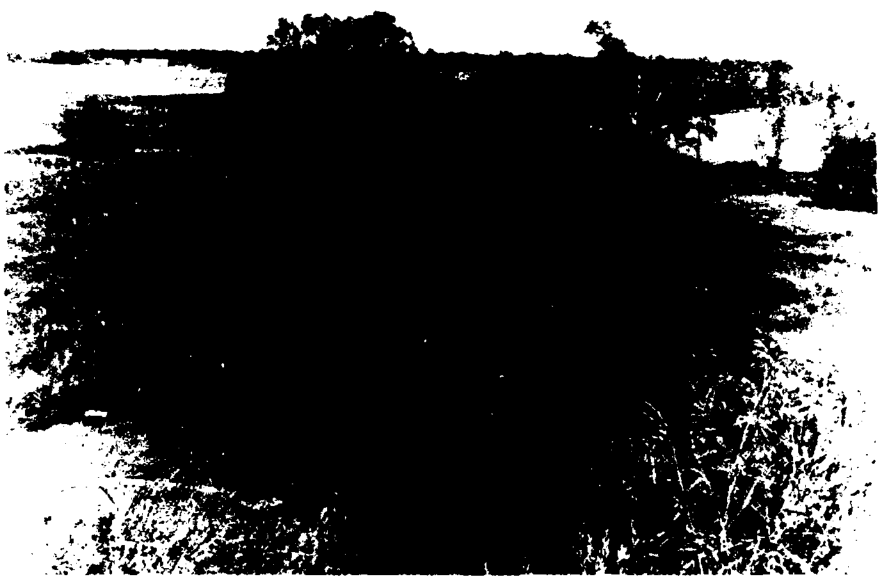

Figure 4. Winterville State Park, Miss., showing plaza area and smaller mound stabilized with Johnson grass (*Sorghum halepense*)

site stabilization in some instances but, generally, the larger the plant, the greater the chance that its root system will be destructive of the archaeological property.

53. Selection of cover plants must be based in part on the known or predicted contents and subsurface configuration of the site. Plant selection, if species are being intentionally added, will be site and region specific,

but there are some general considerations that should be taken into account. Plants with deep root systems should be avoided since massive root growth can destroy cultural deposits. Further, radiometric materials throughout the cultural deposit are likely to be contaminated by hairlike rootlets. Trees and large shrubs with lateral root systems and enough crown mass to make them susceptible to being blown over should also be avoided since blowdowns of these plants displace large chunks of earth.

54. Another danger of lateral growth occurs when roots grow across and through subsurface house floors. When a site is being revegetated by overplanting, destruction of the resource can be minimized by careful selection of plants to be added, while periodic removal of undesirable species will allow some measure of control over invasion plants. Local foresters (US Forest Service) as well as the SCS can provide information on suitable species.

55. Site preservation through revegetation is one of the least expensive methods of holding a site in place. If natural invasion is used, the only cost involved is likely to be minor surface treatment and the eradication of undesirable species. When planting is involved, surface preparation, plant acquisition and placement, fertilizers, and maintenance costs until the colony is established should be included in budgetary estimates.

56. Preservation of archaeological deposits generally requires less surface modification if naturally occurring materials are used. All of the techniques discussed above can be used on very irregular ground surfaces and are likely to result in a smoother ground surface. Man-made materials have a general tendency to be rigid in nature and may not easily conform to irregular ground surfaces. In some cases, it may be necessary to perform surface leveling or filling first, and all existing vegetation may have to be removed before the preservation materials can be installed. Here, of course, care is essential to minimize impacts to in situ strata.

Continuous concrete slabs

57. In several instances, poured concrete has been used to preserve archaeological properties. In the reported instances of the use of liquid concrete, we found no evidence that forms were used to contain the mix until it had set. Reinforcing wire was used since prevention of vandalism was the main thrust of using concrete and, without wire, the slab could easily be broken and removed.

58. Before a decision is made to pour a slab of concrete over a site, the advantages and disadvantages of such an approach should be taken into account. Some aspects of the use of this technique are more likely to be destructive of the archaeological component than alternative approaches, as discussed below.

59. Before the concrete can be poured, virtually all of the vegetation must be removed from the surface of the site, and major surface irregularities filled or smoothed over. This will help to ensure that the slab is of a relatively uniform thickness and will minimize the amount of concrete used. Care must be exercised to ensure that the extant cultural deposit remains undisturbed; holes that are to be filled should be marked in the manner indicated for earth burial. Hand clearing of the area to be covered will likely be necessary. While the likelihood of major chemical change of the culture-bearing matrix as a result of the addition of the concrete mix is slight, potential change must be considered as should potentially adverse effects from the weight of the slab.

60. Unless concrete is mixed on the site, it is generally acquired as a readymix, and access to the site for the truck(s) is necessary. Some provision must also be made for getting the mix out of the truck's drum and onto the site. Wheelbarrows may be used to transport the mix over the site. Few sites are capable of carrying the weight of the truck empty (approximately 11 tons), much less loaded (15 tons), without experiencing some adverse effects. Thus, it is strongly recommended that trucks of this size be kept off cultural resources unless a causeway is built for their use.

61. After the pavement has been laid, there may still be problems. Along edges which front on lakes or streams or are subject to heavy rainfall runoff, water may erode pockets under the slab and weaken it. These erosional pockets also provide a point of entry for vandals to dig under the slab in search of artifacts.

62. While the pavement will deter the activity of vandals, if not completely stop it, it will also serve to prevent future access to the site by professional archaeologists. However, if the concrete contains reinforcing wire, removal of only a small portion of the slab without weakening the balance of the pavement might be possible. It must be noted that wire does not strengthen the concrete mix but helps to tie the slab together in the event that cracking occurs. Wire within the slab would prevent the removal of

pieces if the slab should crack. Without reinforcing wire, the remainder of the slab may fragment in the event a small portion is removed.

Gunite

63. While readymix concrete must be trucked to the site ready to be poured, Gunite can be mixed in the field and pressure-sprayed on the ground surface. The protective results will be similar to those provided by a readymix pour. The Gunite mixture might not have the same strength as readymix, however, since it does not contain a coarse aggregate.

64. Since Gunite is a mixture of sand, cement, and water, it can be mixed on site, especially if sand and water are locally available. The only items of any weight or bulk to be brought to the site are the sacks of cement and the spraying equipment. Alternatively, the dry mixture of sand and cement can be prepared away from the application area and brought to the site to be mixed with water and sprayed on.

65. Gunite can be used on sites that are sufficiently remote to make using readymix impossible (Figure 5). In those cases, the sites can be hand-cleared, the wire emplaced, and the mixture sprayed on the site. The fact that the material is sprayed in place under force gives it greater strength than an equivalent amount of poured mortar (Mills, Hayward, and Rader

Figure 5. Gunite cover on Bear Creek Shelter site, Lake Whitney, Tex.

1955). Since the mixture is sprayed over the area to be covered in a progressive manner, the thickness of the finished slab can be controlled.

66. Accessibility to the cultural deposit through the Gunite slab is easier than for poured concrete since the hardened Gunite does not have the same strength. Unfortunately, the Gunite slab is likely to exhibit the same erosion problems that would affect a concrete slab. Therefore, subslab erosion would lead to breakage of the Gunite covering if it were severely abused.

Articulated concrete block mattress

67. This form of mattress is a replacement for stabilizing mattresses made of timbers chained together. Concrete block mattresses consist of a series of concrete blocks whose dimensions are 3 ft, 10 in. by 14 in. by 3 in. They are closely fitted and then cabled together with wire rope. They must be put into place on the bank from a specially prepared barge using heavy equipment on the shore to drag the mat into place. Some bank line preparation is necessary so that the blocks will make maximum contact with the ground surface. It is also frequently necessary to clear timber and brush from the top of the bank so that the equipment necessary for installation of the mat can move about. Site destruction can stem from this preparatory clearing if care is not exercised.

68. This technique is primarily for bank line stabilization that would protect archaeological properties as a secondary benefit. The size of the equipment necessary to lay the mat dictates that it be employed on large rivers. If archaeological properties are located along a bank line that is to be stabilized, plans should include those steps that would be necessary to protect the site during the mat-laying operation. Once the mat is in place, the stream side of the site will be fairly well protected from erosion although not necessarily other portions of the site.

69. Erosion between the articulated blocks has been eliminated by the addition of a notch on the ends of the blocks. The weight of the mat plus the cables precludes access to anything beneath the mat; thus, postplacement archaeological projects would be inhibited. That same weight could be a negative factor in using the mat as a means of protecting a streambank property, particularly if the site's contents are fragile.

70. Since articulated concrete mattresses are not designed primarily to protect archaeological sites, installation of the mattress is likely to impact such a property. Cost estimates for placing the mattress are not likely to

address the issue of protecting the site during mat installation, but fiscal considerations for the archaeological property should be included. Costs are likely to be increased if placement procedures must be altered to avoid or to work around the site. Site benefit-cost ratios must be calculated, since rarely would this technique be the first choice to protect an archaeological property. Articulated concrete block mattresses are not suited for use on the horizontal expression of an archaeological property unless they are laid individually. On the other hand, other methods are available that address the problem of site protection at a lower cost.

Cellular blocks

71. A number of companies manufacture trade name concrete blocks that can be used for preservation purposes, e.g., GOBI blocks (Figure 6). Unlike

Figure 6. Concrete block revetment in place on Connecticut River, Mass.

the blocks used in an articulated mattress, cellular blocks are not connected and are laid one at a time since the blocks normally weigh almost 100 lb each. Placement must be by hand and is frequently over a filter fabric or some other filtering material. Ground surface preparation is necessary if the filter is not a gravel course that can be used to smooth out the ground surface. Vehicle access to the site must be good to allow transporation of the blocks to the point of placement.

72. Solid blocks have the disadvantage of their weight, which could damage the contents of a site when emplaced. In addition, they form a solid pavement which inhibits revegetation. In spite of the weight of each block, a determined vandal could remove any of the blocks with little difficulty, thus negating their protective value.

73. Some forms of cellular blocks are cast in geometric lattice patterns that, when laid together, produce an open-patterned ground cover. Usually, these are laid on a filter cloth or stone filter base. Since each block articulates with other blocks at specific points, ground surface preparation is usually necessary. Filter gravel or a sand course can replace some of this surface preparation.

74. Since cellular blocks are cast in a lattice design, there are open areas in each block which reduce its weight. These open spaces permit natural revegetation of the site to occur, or if desired, selected cover can be planted through the holes.

75. The lattice-patterned cellular blocks can be removed easily and, as a result, provide little in the way of protection from vandalism. They are excellent erosion control devices, however, particularly when they are used in combination with a filtering agent and are revegetated.

76. Costs include block acquisition and transportation, labor costs for site surface preparation, cost of the filtering agent and its installation, and labor to lay the blocks.

Interlocking blocks

77. As an alternative to concrete blocks, at least one company is producing interlocking blocks of recycled plastic. Unlike cellular concrete blocks which are laid side by side, these blocks have tongue-and-groove edges that fit together. The backs of the blocks are hollow and, once laid, can be filled through holes in the top by sweeping or washing sand into the cavities. The use of a filtering material under these blocks is unnecessary unless a sand course is employed to level the ground surface. Ground surface preparation must be completed before these blocks are laid because their interlocking edges fit tightly together.

78. When a smooth surface is present, these blocks have a number of advantages over cellular concrete blocks. They are lightweight and can be easily moved during hand placement. They are made of chemically inert plastic and should have no impact on the chemistry of an archaeological property.

Holes through the blocks permit movement of moisture and growth of vegetation. They can be made to fit over curved surfaces such as mounds and still interlock if the rate of curvature is not too great. According to the manufacturer's representative, once all the blocks in an area are tightly laid, none of the center blocks can be removed. Blocks should be laid beyond the outer edges of the site to ensure that the deposit is covered. If the effort required to remove the blocks from over the site does not provide a complete deterrent, the effort required will present a nuisance factor and the site will be protected from vandals as a result. These blocks are suitable for use on streambank slopes as well as horizontal cultural deposits. Once firmly stuck to the ground, they resist the forces of erosion as well as concrete materials.

79. Cost factors include the blocks and their transporation, preparation of the ground surface (probably by hand), and hand placement of the blocks on the site. If seeding or other vegetative cover is to be used, cost of these materials and fertilizers should also be included.

Asphalt mixes

80. In areas where riprap use would be appropriate but good stone is scarce or too costly, asphalt mixes may be used.

81. Use of asphalt mixes for preservation of archaeological sites has several drawbacks that generally limit their use to a "last resort." Hot mix asphalts are laid by machinery especially designed for the purpose. For asphalt mixes to work properly, the area to be covered must be cleared of all vegetation and be smooth and level. Site accessibility must be good, for entry of the asphalt-laying equipment and the heavy trucks delivering the material. There is still the potential that either the delivery trucks or the asphalt machine might damage the surface of the site.

82. Since the asphalt covering constitutes a continuous slab, the site area underneath would be relatively well protected. A 3- to 4-in.-thick slab would be difficult to break through by hand. While this would inhibit vandals, archaeological research activities in the future would be hindered by the need to remove the slab. In addition, if the slab is laid on a slope, erosion of the edge areas could occur unless special precautions were taken.

83. Asphalt is chemically stable but is derived from fossil fuel. Any degeneration of the mixture could introduce contaminating hydrocarbons into the artifact-bearing matrix. Of especial concern would be the cleaning of

equipment during the process of laying the mix. Diesel fuel or kerosene used to clean and lubricate the equipment would soak into the cultural deposit like water, thus introducing additional contamination.

84. Cold mix asphalts, in quantities large enough to be useful for site preservation, would be subject to the same transportation problems as hot mixes. Cold mixes could be spread by hand but would also have to be compacted by hand. Compaction over large areas by hand would be time consuming. Rolling packers could be used but might be difficult to get to the site.

85. Neither hot nor cold asphalt mixes are recommended as primary site preservation materials, but are presented here as alternatives. Installation costs should include the preparation of the site, procurement and laying of the mix, and any special treatment necessary to stabilize the edges of the slab.

86. As a note, submerged resources could be covered with an asphalt mat by dropping hot mix asphalt through the water onto the area to be preserved. Keown et al. (1977) report the experiments completed on the Lower Mississippi and point out the apparent success of the method for bank stabilization. However, no evidence was found that this technique has been used in an archaeological context.

Soil cement

87. In streambank stabilization, soil cement is generally used on upper banks and horizontal surfaces. It is also used as a base for roadbeds. Soil cement contains between 8 and 15 percent portland cement and, when set, is relatively inflexible and impermeable. In roadbed construction the cement is added to the roadfill with a machine. In an archaeological context, the site would first have to be cleared of all vegetation. A further requirement is excavation within the top 4 to 6 in. without creating a major site disturbance. Raw cement is generally transported to the site in bulk quantity, although archaeological site use might be accomplished on a sack-by-sack basis.

88. In addition to the disruption of the upper portion of the cultural deposit to allow the mixing of the cement into the soil, there is the potential for chemical change of the soil matrix. The addition of the cement could possibly change the pH of the matrix from slightly acidic to slightly basic.

89. Soil cement has a diverse history of use in a bagged form as a replacement for riprap (Keown et al. 1977) and as a means of flood control.

The sacks used are biodegradable and after a period of time rot away, leaving a cement/soil or sand casting in the form of the sack.

90. A potential problem with sacks of soil cement as a preservation method is their weight on the cultural deposit. However, the weight is likely to be less than that of riprap.

91. Installation includes cost of the cement, cost of mixing the cement with the matrix material and, where necessary, artificial watering to ensure that the mix reaches an appropriate hardness in the shortest period of time. Clearing and site preparation costs should also be calculated.

GEOWEB

92. GEOWEB is the trade name for an expanding system of honeycomb cells originally developed for sand containment in access road construction on beaches. The cells are formed when recycled plastic strips are ultrasonically welded together in pieces that will cover an area 20 by 8 ft with cell depth measuring 8 in. The material is chemically inert and is treated with carbon black to prevent solar deterioration. Each piece collapses accordion style to 11 ft by 5 in. by 8 in. for shipping and weighs very little, making transportation easy.

93. While the original intent of the product was for road construction, its archaeological site use is being tested in Tellico Lake, Tennessee (Thorne 1985). Those tests were designed to determine if the GEOWEB sections would successfully trap silt and sand being swept across the bottom of the lake. The 8-in. dimension of the sections was cut to 2 in., thus providing quadruple coverage for each section and reducing the material cost per square foot by 75 percent. At the time the test sections were installed, the archaeological sites to be covered were under as many as 18 in. of water. Unfortunately, the sections had a tendency to float slightly, even after they had been pinned to the bottom. Those cells that were fixed to the bottom filled with sand while those that were not pinned down sufficiently did not. After the water level dropped, the sections were adjusted and some of the cells filled with windblown sand and silt and vegetation began to become established. This method of preservation appears to be particularly well suited to areas that are alternately subjected to sheet erosion and aeolian action.

94. GEOWEB has a number of advantages over some of the other materials described above. It is light and can be transported easily, is relatively inexpensive, can be laid by two people, and will fit over terrain that is

nearly level. It can be cut down from its original cell depth with a hand saw, providing cell depths that are appropriate for a particular application. Revegetation within the cells is possible since each cell is about 6 in. square (Figure 7).

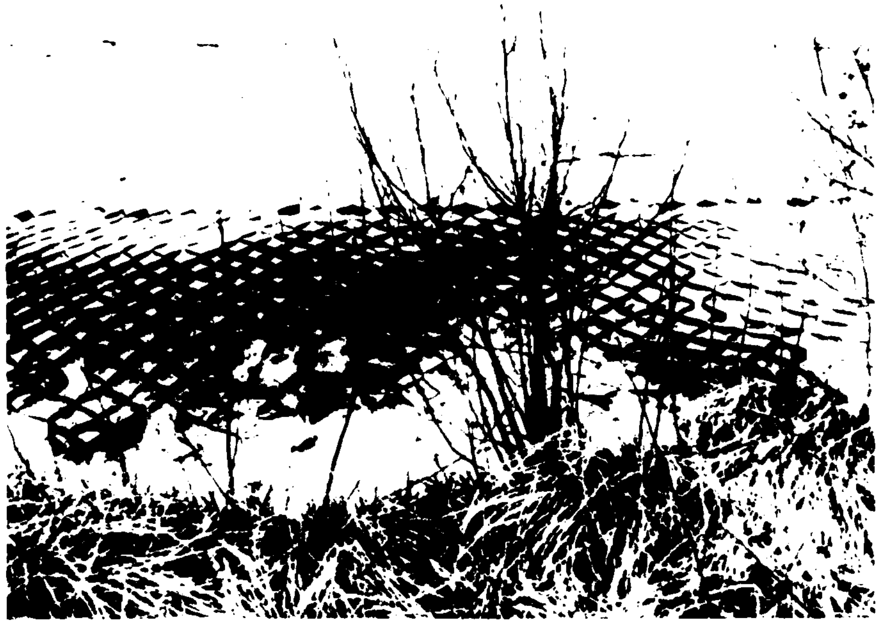

Figure 7. GEOWEB installed in Tellico Reservoir, Tennessee

95. Among the disadvantages of GEOWEB are its propensity to float if it becomes submerged. The sections can be readily vandalized and removed with ease to allow access to the cultural deposits beneath, as the material can be easily cut with a sharp knife. This limits the material to erosion control rather than vandalism control.

96. Fiscal calculations should include the cost of the GEOWEB and shipping fees, labor costs to remove vegetation, labor costs of two to four people to install the material, and costs of any fill material that is to be added to the cells. Pins to hold the material in place can be made from coat hanger wire. Once stretched, the cells around the perimeter of each section can be filled with soil, anchoring the section in place.

Vertical - Natural

97. As noted earlier, this report makes the distinction between archaeological properties that require preservation along the horizontal plane as opposed to properties that require vertical treatment. Such a distinction was considered necessary since treatments for vertical and sloped surfaces may differ from those considered adequate for horizontal surfaces. Forces acting on sloped surfaces may be the same as those which act on the horizontal, but their slope may magnify the negative effect, i.e., erosion will proceed at a greater rate on slopes. Many sloped and vertical surfaces that contain archaeological materials are part of the shoreline of lakes or streams and are susceptible to the effects of wave action and stream currents.

98. Streambank stabilization and protection mechanisms have been considered and discussed by a variety of writers (Keown et al. 1977, Keown and Dardeau 1980, Bowie 1981, Henderson and Shields 1984). None of these works addresses cultural resources and/or archaeological remains as a part of the environment that should be protected by the installation or use of the techniques that are discussed. None suggested that the installation of bankline stabilization mechanisms might be as destructive to the cultural resource as are other forces that are acting to destroy the property.

99. During the planning phase of an archaeological site preservation project, careful attention should be paid to the extent of site damage that is likely to accrue during site preparation. In those cases where bank preparation through excavation is necessary, archaeological salvage operations may be necessary. This fact points out the necessity for professional guidance during the preservation process. Professional consultation can help to ensure that the remedy does not intensify the problem, especially since most actions taken must comply with the specifications of National Historic Preservation legislation.

Rock berms

100. The construction of rock berms to protect archaeological properties is quite similar in effect to covering the horizontal portion of a site with riprap. The protective capabilities are essentially the same, but installation problems may differ. Some form of filtering agent is likely to be desirable in most cases so that water passing through the large outer rock

will not erode the site beneath the berm covering. Filter cloth, as well as gravel and/or sand filters, is appropriate.

101. Rock berms are appropriate protective devices for archaeological properties that are exposed on lakeshores, along streambanks, or in the banks of man-made ditches (Figure 8). In almost every instance, some ground surface

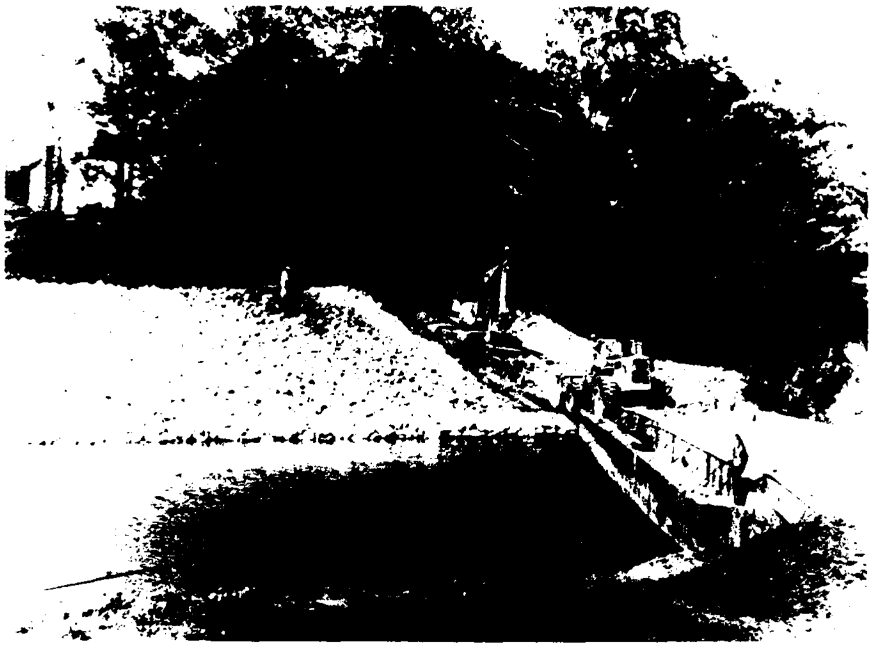

Figure 8. Rock berm at Poverty Point Site, La., showing placement of tieback on upstream end of berm

preparation may be necessary and would include the removal of vegetative cover and filling and smoothing of the surface. Slope angle and the potential impact on the cultural deposit would be prime considerations in determining whether slope preparation would be by hand or machine. If extensive cutting is necessary to prepare the slope, salvage excavations might be necessary in that portion of the site.

102. The stone facing on the berm will actually serve a dual purpose--to protect both the archaeological property and the sloped bank from erosion (Figure 9). On the surface these functions may appear to be the same, but the presence of cultural debris must change the way protecting the sloped bank is viewed. No testing has been completed to ascertain the effects of the weight of protective stone on archaeological properties. The most reasonable approach is to use the least weight of stone per square foot as possible, while ensuring that the surface is adequately protected from erosion.

Figure 9. Finished rock berm at Poverty Point Site, La.

103. Use of local rock should always be considered as the first choice, since it is likely to cost less and should be chemically compatible with the culture-bearing matrix. Since aesthetic quality should also be a consideration, local stone will generally blend with an archaeological site's microenvironment better than material brought in from elsewhere.

104. If a gravel or stone filter bed is to be laid beneath the rock of the berm, care should be exercised in selecting the material for the filter so that mixing with the cultural deposit does not occur. If, for example, the site to to be protected is a lithic workshop or a habitation area containing lithic debris, the filtering agent should not be the same stone as the raw material used in stone tool production.

105. Since a prime area for employing a rock berm to protect an archaeological property is along the shore of a lake or along the bank of a stream, care must be exercised in designing and installing the berm. In order to ensure that the toe of the berm is not eroded, it may be necessary to install some form of toe protection at the base of the slope. If the lowest end of the stone terminates high enough up on the bank, it may be necessary to install a windrow revetment.

106. Essential elements in the installation of a rock berm are vehicle and equipment accessibility and the weight of the equipment and the stone. Care must be exercised to ensure that haul roads do not cross the horizontal extent of the archaeological component. To ensure that damage is minimized, a built-up haul and work road may have to be constructed along the top of the bank. Placement of the rock should be accomplished from the bottom of the slope if at all possible. Care must also be exercised to ensure that archaeological properties away from the work area are not inadvertently impacted.

107. Cost estimates for installing a rock berm must include site preparation expenditures, filter cloth or rock and its placement and acquisition, and placement of the rock for the facing.

Sandbags and filter cloth

108. The use of sandbags over a filtering material, either fabric or gravel, has a very limited range of use in the archaeological context unless the sand contains an admixture of cement. Without cement, the protective value of the sandbags will decline as degradation of the bags advances. With the cement mixture, the protective life of the installation will be considerably extended.

109. The advantages and disadvantages of soil cement, which a sand-cement mix would be, have been discussed as a protective device for horizontally defined archaeological properties. Essentially the same considerations must be given to sandbag placement as are given to the development of a rock berm structure. A major exception would be the possibility of acquiring the sand from the immediate vicinity of the site to be protected. In that case, the major items to be transported to the work area would be bags to be filled and the tools necessary to clear the site and fill the bags. If some form of revegetation is to be used in conjunction with the sandbags, the longevity of the system of protection can be extended.

110. One attempt has been made to preserve an archaeological site against eolian erosion at San Miguel Island, California. Overgrazing has led to an almost complete loss of vegetative cover, and deflation of the island is occurring rapidly on the windward side. The effectiveness of the various sandbag/filter cloth applications is still being monitored, but initial indications are that rather than retarding erosion, they may actually speed it up (Snethkamp 1983).

111. However, if sandbags and filter cloth prove to be a reasonable preservation mechanism, the technique can be one of the cheapest available. Cost estimates should include price of bags, the sand (if it must hauled in), the filter fabric, site preparation, and filter fabric/bag placement.

Timber bulkheads and fill

112. Wooden retaining walls used in combination with backfilling might prove to be an appropriate choice for shoreline protection. As is the case with metal and fiberglass bulkheads, the structure is placed away from the shoreline and, once erected, the area between the shore and the rear of the bulkhead is backfilled with some culturally sterile material.

113. If possible, the bulkhead should be built during low-water stages so that construction can be carried out on dry ground. If the water does not recede sufficiently to allow dry ground construction, ideally the work should be completed from a barge so that the archaeological materials are minimally disturbed. Pilings can be driven from the barge, with the segments of the bulkhead prefabricated on the deck of the barge and lifted into place from there. If the bulkhead is to be of continuously driven pilings, barge construction is still preferred since little bank line preparation would be necessary. The bulkhead should be built to a height that will allow the entire shoreline or bank splash zone to be protected.

114. The fill material that is placed behind the bulkhead must be culturally sterile to prevent any mixing of archaeological materials with foreign artifacts. Dredged material makes excellent fill in most instances and provides an easy and economical means of dredged material disposal. If any portion of the archaeological deposit is to be covered during the backfilling operation, a divider of polyethylene film or filter fabric should be used to identify the interface between the site and the fill material.

115. Timber bulkheads are generally less expensive than those made of other materials if only initial installation costs are considered. The continuous cycle of wetting and drying combined with organism activity dictates that a program of chemical preservative maintenance be implemented if the maximum life of wooden bulkheads is to be realized. Initial cost combined with long-term maintenance makes timber bulkheads comparable in cost to structures of metal or fiber (Keown et al. 1977).

116. An alternative plan for the timber bulkhead might be one of anticipated degeneration with no plans to repair the rotting structure. The intent

would be for a new shoreline to be allowed to develop out of the fill material. In that case, rock or some other erosion-resistant fill should be chosen. Deterioration of the retaining wall would allow the fill to slump into place in much the same manner that the rock in a windrow revetment would be exposed down the face of a bank.

117. Several advantages of utilizing a bulkhead can be listed. With the technique, there is a lack of direct impact on the archaeological resource during construction if the wall is installed during low-water stage or from a barge. The shoreline is effectively moved away from the site, and the cyclical wetting and drying of the cultural deposit is considerably reduced. The threat of further erosion of the property is removed with the lateral movement of the shoreline. If the retaining wall is allowed to rot, the intervening fill will help ensure that erosion of the resource does not reoccur.

118. Cost projections must include the price for the timber, which should be chemically treated, and cost of installation of the bulkhead. Barge rates as well as crane/dragline costs should be included. If the fill material is to be brought in, its cost must be included.

Vegetation

119. The use of vegetation as an appropriate means of preserving sloping banks has been well established and has proved to be as effective as it is aesthetically appealing. Problems related to the use of vegetation in archaeological site projects have been discussed earlier, but in the context of a horizontal plane. The sloped portion of sites, particularly those adjacent to streams and along shorelines, are especially susceptible to erosional forces such as rainfall runoff, stream currents, and shoreline splash.

120. Grass has proved to be the most effective retardant for streambank erosion, once it becomes well established with aerially dense blades and a well-developed root system (Figure 10). Scouring can be dramatically reduced with a well-established stand of grass since stream velocity can be reduced by as much as 90 percent at the water/soil interface. Ideal grasses are flood tolerant and have a tendency to have deep root systems. While deeply rooted grasses are not considered ideal for covering of archaeological units, stabilization and contamination is much preferred over erosional loss.

121. Some bank preparation is likely to be necessary, and archaeological data recovery may be required in those portions of the site to be damaged during slope dressing and planting. Care must be exercised to ensure that the

Figure 10. Sloped and revegetated bank,
Grainger Reservoir, Texas

portion of the archaeological property on top of the bank line is not damaged or destroyed. Seeding or sprigging should be done by hand where possible so that the cultural deposit receives the least damage during the revegetation process. Establishment of the growth can be encouraged and the slope held by using natural mulch during mechanical seeding. Other alternatives for use as stabilizing agents and seed covers include excelsior mats and appropriate woven filter fabrics. Latex acrylics can be used in hydroseeding; these literally glue the soil particles together until the seeds germinate and become established. The rate of application of the emulsion is such that moisture will soak into the soil and the roots can become established. These copolymer emulsions are chemically stable and a 2-percent solution has a pH of 7.38, only slightly higher than neutral. Soil Seal Corporation indicates that their particular product will change soil pH by no more than 0.8 pH points, which may not have an undesirable effect on archaeological materials. Presumably, other manufacturers' copolymers behave similarly.

122. Soil bioengineering is a bank stabilization process that involves plant and soil layering in progressive steps with species changed to best fit the differing microenvironments from the base to the top of a bank. A major advantage is ecological compatibility with the surrounding environment. A

major disadvantage, in at least some instances, is that extensive dirtwork must be completed. Dirt is generally removed and gradually replaced with the plantings that are added until the bank line is repaired. Since the bank line is removed, some damage to an archaeological component could occur.

123. On some steeply sloped surfaces such as hillsides or mounds, hand-planted grasses or creepers are desirable. Care must be exercised to ensure that these introduced materials will not become noxious weeds, as kudzu (*Pueraria lobata*) has become. Johnson grass (*Sorghum halepense*) has been used in archaeological stabilization projects, as has periwinkle (*Vinca minor*).

124. Cost estimates for revegetation have a very broad range and are reflective of the method chosen. Sprigging with locally acquired periwinkle or hand-seeding without surface preparation would be the least expensive, while bioengineering would probably be the most expensive.

Vertical - Man-Made

Bulkheads

125. Archaeological site preservation using bulkheads has been generally discussed in the earlier section on timber bulkheads. Alternative materials for bulkhead construction include concrete, metal, and fiberglass. Each of these has different installation requirements from timber and are likely to present slightly different problems during construction. Postconstruction advantages and disadvantages would be the same as for a timber bulkhead.

126. Differences in installation features for man-made materials should be taken into account when considering the selection of bulkhead materials. The potential damage that might occur as a result of construction should be weighed against the long-term advantages of material selection. Concrete bulkheads require the construction of forms and access to those forms so that the concrete can be poured. Low-water construction efforts would be ideal, particularly if the work reach is away from the bank line containing the cultural material.

127. Bulkheads made of metal or fiberglass consist of individual sheets that are put into place one at a time. These sheets overlap along the edges where they are joined. They are capped continuously so that the ends of the sheets are not exposed (Figure 11). Placement of the sheets can be done mechanically (driven as piles) or with an air jet. The latter is used to open

Figure 11. Bulkhead installation at the Roods Creek Site, Walter F. George Lake, Georgia (courtesy of Jerry Nielsen, US Army Engineer District, Mobile)

a narrow trench into which the sheet of material is set. Minor filling might be necessary to hold the sheets in place until most of the fill material is in place behind the wall.

128. Care must be exercised in the placement of sheet piling. Air jetting would be relatively more destructive than driving but, with care, only a small area should be disturbed in either case. The use of sheets eliminates the need to drive deep pilings. Backfilling behind bulkheads erected in this manner would be the same as for a timber bulkhead.

129. If the purpose of the bulkhead is to protect a resource that has a submerged component, care should be taken to protect the submerged portion of the site that lies outside the bulkhead. Wave forces that would normally be dissipated along the shore or bank line are turned downward against the base of the bulkhead and can erode the bottom to the extent that the wall can collapse.

130. Costs of the initial installation of bulkheads will vary considerably, depending on the material from which the bulkhead is made and the method of installation. For example, dry ground work should cost less than working off a barge, and bulkhead construction with concrete requires more

hand labor for form construction and removal. However, according to Keown et al. (1977), if the long-term maintenance costs are considered, bulkheads should be competitively priced for all materials regardless of whether they are man-made or of timber.

Used-tire mattresses

131. Tire mattresses serve two purposes: first, to absorb the destructive energy of waves, and second, to deter the activities of vandals who would dig into the property.

132. In the traditional manner of installation, the tires are laid side by side and tied or banded together with some material that is not biodegradable. For the mat to be effective, the sloped surface should be as smooth as possible and free of all vegetation. It is important that the tires make good contact with the ground surface so that erosion cannot begin. The tires are not likely to move after they have been fastened together; therefore, anchoring of the mat is generally unnecessary.

133. A tire mattress has been installed over the face of a midden deposit on Seven Mile Island in northwestern Alabama (Thorne 1985) to test the applicability of the technique on vertical surfaces (Figure 12). As noted, the purpose of the mat is to retard erosion, which at Seven Mile Island consists of bank slumpage. The effects of wave and current erosion will be reduced, and the mat will provide a barrier to the people who dig for artifacts on the site. When the mat was installed, it was assumed that the tires would trap sediment from high-water stages of the Tennessee River as well as material from the site. The normal course of events would then include the growth of vines and shrubs that would root in the tires. Eventually this growth would cover the exposed bank. Since the bank to be protected was vertical and had to be protected in an "as is" condition, it was necessary to suspend the tires with the beads as far apart as possible. A technique was devised to sew the faces of adjoining tires together.

134. Since the site is accessible only by boat, the tires were laid out, numbered, and drilled for sewing before being transported to the Island. The mattress was suspended with 3/8-in. wire rope from trees growing along the top of the bank, with care being exercised to ensure that the rope did not girdle the trees.

135. Since its installation, the tire mat has been visited several times to assess the adequacy of the technique. Slump material is accumulating

Figure 12. Vertical tire mattress suspended in front of shell midden, Seven Mile National Register District, Alabama

in the tires in the lower rows, and sediment has begun to accumulate from high-water stages. Vandalism has been deterred to some extent, although it has recently been reported that looters are using the tires to stand in while digging into the top of the bank behind the tires.

136. The cost of installation of a tire mattress is largely labor, assuming that used tires can be acquired at no cost. Other costs include the wire rope used and transportation of the laborers and materials to the site.

Gabions

137. Walls of riprap or stone-filled gabions are often used for stabilizing high and nearly vertical banks (Figure 13). Modern gabion baskets are of galvanized wire, are square, and are delivered unassembled. Before they can be put into place and filled, the bank to be protected may need to be dressed to an angle that is tilted slightly away from vertical. The need for dressing to less than 90 deg becomes greater with the height of the bank. If the cultural material extends to the edge of the bank line, this slope preparation can be destructive. In some cases, it is necessary to build a bench-like base of gabions to support the vertical wall.

Figure 13. Gabion wall along Interstate 40,
Harreman, Tenn.

138. Assembly of the gabions is a hand operation as is the process of tying each new basket in the sequence to baskets adjacent to and below it. Filling of the baskets is generally considered to be a hand operation also, but mechanical filling is possible. Care must be taken to ensure that the site is not damaged during transportation of the stone to the gabions. Since filling of the baskets is generally completed from the top of the bank, some degree of site damage or destruction is likely to occur unless care is exercised.

139. Even though the weight of the gabion mass is great, there should be little or no weight-related impact on the archaeological deposit since the wall is adjacent to rather than on the cultural deposit.

140. The major disadvantage of the use of gabions is cost, since their placement is labor intensive. In addition to labor costs, estimates should include any preparatory dirt work, the gabion baskets, the stone and its transportation, and any top bank work that would be necessary to protect the site from the heavy equipment used in the installation.

Stream Training

141. The techniques discussed earlier are all applied directly to a bank and are intended to serve as buffering agents against the forces of erosion. There are other alternatives that can be used either singly or in combination with the previously discussed techniques. These alternatives are frequently termed stream training. Once in place, these mechanisms divert the current of a stream away from a bank line and, in so doing, minimize its erosive action. Included among these alternatives are jacks, fences, and dikes.

Jacks

142. Jacks are made of three linear members, usually concrete or steel that are bolted or welded together at the midpoint, so that any one member is perpendicular to the other two. They are set in a line in the stream separated by intervals of 15 to 30 ft. In some cases, they may be cabled together although their weight and configuration generally hold them in place. If the jack field is effective, flow velocity can be reduced from 5 fps to 0.5 fps with comparable erosion-reducing results along the water/bank interface. Since the rate of flow is rapidly reduced in the area of the field, suspended sediments are allowed to drop out and help rebuild the bank line. Vegetation, especially grasses, growing up between the jack field and the bank line provides additional protection to the erosional surface (Keown et al. 1977).

143. If the jack field is placed in a stream that is likely to carry sticks, brush, and logs during periods of high water, site destruction may occur. This occurrence is a result of trash and logs catching against elements of the field and turning the flow into the bank rather than away from it. When this happens, the force of the water removes the bank rather than deepening the channel as intended.

144. Use of jacks can also be potentially destructive to the site if care is not exercised during ingress and egress to the work reach. Individual members of the jack are relatively heavy and must be held in place by a crane or dragline until they can be bolted or welded. This equipment has the potential for damaging the property to be protected.

145. Jacks can be prefabricated away from the work site, dismantled, and then reassembled at their point of placement. Costs include the individual pieces of the jack, bank preparation for placement of the jacks, and labor.

Fences

146. Fences placed parallel to the direction of flow are generally temporary measures that are used to slow the erosion process and allow the revegetative process to become completed.

147. Transverse fences promote the deposition of sediment. They are placed so that debris is trapped or turned away from the bank and into the current. Fences that are intended to trap debris against the bank are set at an oblique angle upstream and act as a debris funnel. Once the accumulation of debris is sufficient to slow the current, sedimentation will begin to fill the space between the fence and the bank. The danger for the archaeological property is that the debris trapped by the fence will turn the flow of the stream against the bank and further erode the site.

148. An advantage to using fencing to train the flow of a stream is that locally available materials can be used. Fencing material can range from wire mesh to creosoted boards.

149. Cost for construction of a deflection fence varies with material locally available and the kind of fence (material) to be installed. Estimates should include labor as well as materials.

Dikes

150. Dikes function much like fences to deflect the eroding current away from the bank of a stream or river. This kind of structure is of two basic types, permeable and impermeable.

151. Permeable dikes slow the rate of flow of the current and encourage the deposition of sediment. An impermeable dike effectively reduces the width of the stream and causes the main channel to scour deeper in response to the need for equal square footage to flow area. Scouring and deepening of the channel ensure that the stream can continue to carry the same volume of water.

152. Permeable dikes are more beneficial in protecting archaeological properties since their purpose is to encourage sedimentation and bank line building. Most permeable dikes are composed of timber piles and range in design from piles with face boards and horizontal bracing to single piles or clumps of piles. The spacing of the piles or clusters varies with the type of sediment to be deposited. The finer the sediment, the closer the spacing of the piles should be to reduce the flow of the current most effectively. Screening material can be suspended from the piles to encourage more rapid

sedimentation. Once the sedimentation proceeds to the proper point, revegetation will begin and the bank line will be further protected.

153. Impermeable dikes contribute to cultural deposit stability by moving the stream's thalweg toward the center of the stream and away from the bank (Figure 14). Impermeable dikes would effectively move a stream's navigable channel away from an eroding shore and thus reduce the erosional forces created by boat traffic.

Figure 14. Transverse dikes, Chama River, N. Mex.

154. A potential danger for both kinds of dikes is that trapped debris might cause the main current flow to flank the dikes and erode the site. Permeable dikes are likely to be more susceptible to flanking than impermeable dikes.

155. Cost of a dike system is likely to be high, possibly exceeding the value of the benefits. Material cost will vary with location as will the cost for the various kinds of construction. Heavy equipment necessary to drive the piles or place the material for an impermeable dike may damage the archaeological property during the construction process.

Pedestrian/Vandalism Control

156. Virtually all of the preservation techniques discussed to this point have had the goal of protection of cultural resources from natural forces. In some cases, e.g., riprap overburden or a tire mattress, a secondary function was to limit access to the artifact-bearing portion of the site. Some sites need to be protected more from human access than from the ravages of natural forces. Virtually all of the respondents to the survey identified vandalism as a major cause of destruction of cultural resources. Some of these acts of desecration were not intentionally malicious and not necessarily destructive in and of themselves. In some cases, site destruction results from the cumulative effects of such mundane acts as people or animals constantly walking across an area. The direct solution is to limit access in an appropriate manner. A number of techniques have been used on archaeological sites which are similar to those that limit access to other restricted areas.

Fencing

157. Fencing of archaeological properties has proved to be an effective deterrent, limiting access by humans as well as animals (cattle, etc.). Fences have been used to completely restrict ingress and to channel movement around sites that are open to public view and inspection (Figures 15 and 16). They are obviously not foolproof methods of site protection since they can be cut or climbed with relative ease. In remote areas, fencing serves to remind honest people that they are not to violate the property.

158. Fencing, combined with patrolling of the resource by a security force, will provide better protection than fencing alone. In many instances individuals responsible for patrolling a property will be responsible for the security of adjacent or nearby facilities. It might be possible to arrange for the resource to be included in the normal patrol itinerary of local law enforcement agencies, although this is not likely, since the protection of archaeological data is generally not considered to be a police matter.

159. A major advantage of fencing a property is the relatively low installation cost. Wooden fences would be impractical because of the degree of maintenance that would be required to realize the maximum lifespan of the wood. In the case of certain resources, ornamental fencing of wood or timber might be more appropriate and the long-term maintenance cost justified. Such

Figure 15. Protective fencing, Fort Hood, Tex.

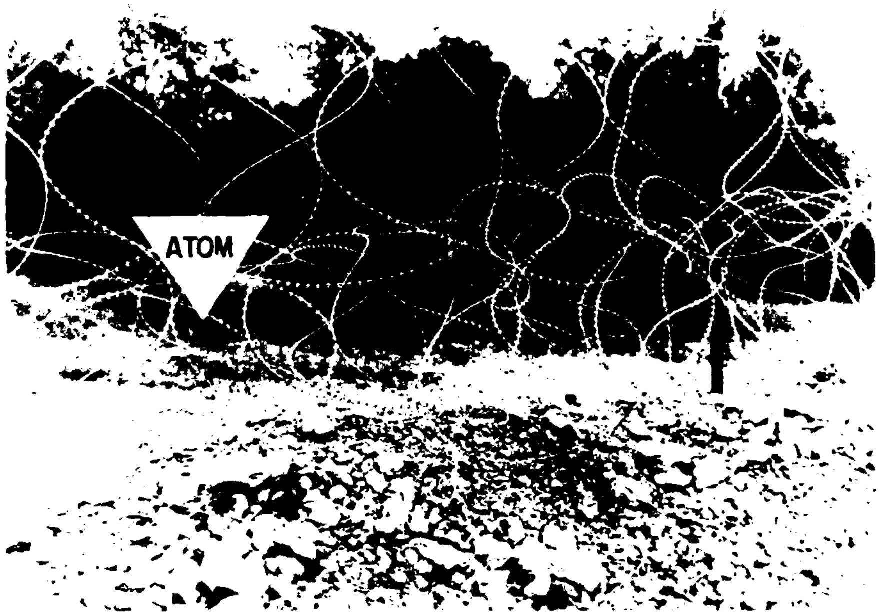

Figure 16. Protective fencing with bogus sign, Fort Hood, Tex.

would most likely be the case for public use areas whose regular maintenance would be included as a part of the normal budgeting process.

160. Metal fencing would require minimal maintenance on a periodic basis. Routine removal of grass, weeds, woody plants, and vines from and along the fence would help ensure that the maximum life of the fence is realized.

161. The major disadvantage of using a fence to limit access to a property is that fences will largely keep out only those people who are not bent on destruction. The need for relatively frequent maintenance, principally plant removal, will add to the long-term cost of the preservation process. A fence is also likely to call attention to the presence of an archaeological resource that might go unnoticed if the fence were absent.

162. Cost calculations should include clearing of the path of fence alignment; the fencing material, including posts, gates, bracing, and post caps; and installation.

Signs

163. Cultural resource managers frequently express dismay at the prospect of signing archaeological properties, arguing that the signs effectively announce the presence of the resource. There is little doubt that this is indeed the case, but enforcement of 18 U.S.C. Section 1361 is difficult at best and impossible at worst if signs are not in place during acts of vandalism. One of two general signing approaches may be employed on undeveloped archaeological properties, with both presenting essentially the same message. The difference between the approaches is in how the message is stated. One approach appeals to the better nature of mankind and asks that the resource be left intact for this and future generations to enjoy. The other approach is more direct, indicating that the property is posted and protected by Federal statute, and violators will be prosecuted.

164. In reality, there probably are very few sites that have the potential for producing large numbers of artifacts that are unknown to collectors. Under these circumstances the placement of signs would not really constitute site location advertisement. To believe that collectors and artifact hunters do not have mental models for site locations is being naive about their abilities. It is preferable to let them know that we recognize their talents and are prepared to protect our heritage. The use of signs to help limit access to a site is more effective if some other technique is used in combination with the signs, e.g., fencing or patrolling. In addition, public

announcements of the successful prosecution of vandals will serve to emphasize that destruction of cultural resources is a serious offense.

165. Site signing is one of the cheapest of the techniques that can be directly applied to site preservation. Sign cost depends on the type of sign (metal or paper), its complexity with respect to printing, and the labor required for installation.

166. Once signs are erected on sites, Federal land managing agencies should make a diligent effort to protect those resources. Such frequently is not the case, with some managers expressing ignorance of their responsibilities under the law. Most land managers truthfully say that they cannot effectively protect and manage the resources under their charge because of insufficient budgetary support and staff shortages. Even so, Federal land managing agents are charged under Executive Order 11593 and the National Historic Preservation Act (NHPA) (Public Law 96-515) as amended in 1980 with identifying and preserving those sites under their control. Other protections include the Archaeological Resources Protection Act (ARPA) of 1979 (Public Law 96-95) and the 1906 Antiquities Act.

167. Prosecutions under Public Law 96-95 have been difficult to obtain in the past because most US attorneys felt that the time expended to prepare the case would not be matched with equal penalties upon conviction. The content of the law is presently designed to ensure that our cultural resources are protected. Land managers, as well as other professionals who are interested in the protection of our heritage, must press our public attorneys to pursue prosecutions, even if the penalty that is assessed is minimal.

168. In addition to statutory and regulatory authority for site protection, such as ARPA, Executive Order 11989 provides Federal land managers with both the authority and direction to further protect cultural resources. In this instance, sites can be forcefully protected from the destructive effects of off-road recreation vehicles. Limiting access to sites by closing trails and other routes of ingress will provide the most positive means of protecting sites. Other protective measures would include fencing, posting by signs, or burial under an appropriate fill. If the latter alternative is chosen, sites can then continue to be used for recreational purposes.

169. The cost of compliance with existing statutes will vary between agencies and frequently within agencies. Site identification and protection can and should be a normal part of every agency's budget.

Buried wire mesh

170. At least one attempt has been made to limit access to archaeological materials by burying wire (chain link fencing) above the level of the artifact-bearing strata. Wire does not appear to be a successful means of protecting a property since it can be easily cut with wire cutters or heavy pliers. At best, it is a nuisance to the serious vandal.

171. Installation of the wire is relatively expensive since it must be laid and covered with fill material either removed from the disturbed portion of a site or brought in from elsewhere. Since it must be buried, the act of burial can have a negative impact on the cultural deposit. If fill material is brought to the site, it must be artifactually sterile and chemically compatible with the artifact-bearing soil. Care would also have to be exercised to prevent damage to the site while the overburden is being removed and/or replaced.

172. Cost of a mesh-burying project would include the cost of the wire, labor to hand-place it over the site, and the fill material and its placement. The effectiveness of this technique would be enhanced if it were coupled with patrolling of the area by enforcement personnel.

Deadfalls and driftwood facings

173. Deadfalls can serve as an effective means of masking a cultural resource from view. If the members of the deadfall are piled closely enough, access to the cultural materials can be restricted. Application of the technique is dependent on the availability of trees and brush that can be used to construct the pile. In some instances, tree limbs and other woody debris could be brought to the site from a distant source such as a construction site. Care would have to be exercised to ensure that such movement onto the property was not destructive of the resource.

174. The technique would be most appropriate in those areas that were being subjected to reforestation after the removal of undesirable species. The undesirables could be used to mask the site until new growth had time to cover the property. The nature of the site would dictate the extent to which coverage with downed timber could be utilized, as well as the kinds of regrowth that could practically be allowed to invade the site.

175. Driftwood facings that are used in an archaeological context are similar to tree revetments described by Henderson and Shields (1984). Unlike tree revetments, whose primary purpose is to retard erosion, driftwood facings

function to screen the archaeological deposit from view and thus limit access to the artifact-bearing unit. The elements of the facing also serve to trap silt and bank slumpage and, from that perspective, are similar to tree revetments.

176. Driftwood facings are made of large pieces of driftwood, logs, and complete trees that are collected from the stream and towed to the site by boat. They are then winched into place and secured with wire rope. Since they are partially waterlogged, they are not as prone to float during stages of high water. Their waterlogged condition also makes them heavy enough that they cannot be conveniently moved to expose the face of the deposit. Since there are some voids between the various members of the facings, silt and other sediment will be trapped, and normal alluviation may effectively cover the wood. Indigenous shrubs and vines should find the facing and its gradual siltation to be an excellent habitat, and their growth will help to conceal the site.

177. A relatively short life for a driftwood facing should be expected at the outset as compared to a permanent material such as concrete. The members of the facing should last long enough, however, for other stabilizing elements to become established.

178. The primary cost of installing a driftwood facing is for labor. An adequate boat and motor must be available, and purchased material would include wire rope, crosby clips or similar fasteners, and solid steel pins. The driftwood facing installed at Seven Mile Island on the Tennessee River (Figure 17) was held in place with 3/8-in. flexible wire rope, and wooden posts were driven into the mud of the river bottom.

179. Driftwood facings or, more properly, log revetments are considered to be an obsolete means of stabilizing an eroding bank. They can retard bank loss, but more effective stabilization techniques have been developed.

Figure 17. Driftwood facing installed on midden deposit, Seven Mile Island National Register District, Alabama

PART III: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

180. The intentional preservation of archaeological properties in the United States is almost as old as our formal system of government (Thorne 1985). The means that have been employed to hold our cultural resources safe from the forces of nature, vandalism, and destruction resulting from excessive use generally are the same as those techniques used for stabilizing an eroding streambank or beachline. Many of these techniques are costly to the extent that their use solely to preserve cultural resources appears prohibitive.

181. Appendix A presents the results of a limited questionnaire survey of practicing archaeologists concerning their efforts in preserving sites. The responses to question 2, which asked what methods of site protection had been used, suggest that we are being advised by nonarchaeologists. Cultural resource managers seem not to be very innovative when site preservation is the issue, and we seem to be satisfied with the advice of others. Granted, in many cases, innovation or experimentation is not possible or prudent. However, it is suggested that as broad a range of alternatives as possible be considered before a selection is made.

182. Resource protection and stabilization are marked by a number of problems that must be addressed before a preservation technique is selected. While most of us would like to preserve every site, such obviously cannot be the case. The decision to preserve one site instead of other similar sites must be based on objective criteria. Fortunately, those criteria which are used to judge a property's National Register eligibility can also be applied to the issue of site selection for preservation. Once that decision is made, appropriate preservation techniques must be identified and both the short- and long-term effects of their use must be considered. We must consider how the site will be used in both the near and distant future. In addition, how will adjacent property be used--will it be developed, and if so, for what purposes? We should then try to accommodate the preservation effort to these potential uses. In this way, we are likely to find that the preservation effort will achieve its greatest longevity.

183. This report has intentionally avoided the issue of standing structure preservation and has devoted attention to archaeological properties.

However, it is considered necessary to discuss the impact of three means of continuing to use and preserve historic period properties: (a) structure demolition, with some parts salvaged for reuse; (b) relocation of all or part of the structure; and (c) site relocation. The latter might more appropriately be referred to as false site construction, with the fabricated site to be used by the public. A concern is that we frequently forget that almost every standing structure of National Register significance also has an accompanying archaeological component. If we tear down or relocate the structure or parts of it, care must be exercised to ensure that the archaeological unit is protected. In some cases, after the structure is moved, more traditional methods of preservation may be appropriate for conservation of the archaeological unit.

184. The reader is reminded that the procedures outlined in this summary should be viewed with caution when they are considered for archaeological site preservation. No controlled testing has been completed and no long-term monitoring of preservation experiments has been reported in the archaeological literature to help us judge the relative merits of each approach. The use of common sense is a necessity. As a final cautionary note, archaeological site preservation projects should not be undertaken without the benefit of consultation with a professional cultural resource manager or archaeologist. This report can serve as a guide to potentially applicable procedures, but each preservation case must be evaluated in terms of its unique characteristics.

Recommendations

185. Research for this and other site preservation projects has continually pointed out our professional ignorance of the effects of preservation efforts on archaeological properties. In documented cases of site preservation, little has been done to evaluate the process beyond its visible effectiveness. When the preservation effort has been monitored over a period of time, attention has been paid to the outward appearance of the property but not to the contextual impact of the preservation technique. Most preservation projects have not included a monitoring effort, almost as though there is a tacit assumption that successful preservation is guaranteed. Our present preservation state of the art does not allow us to make such assumptions.

A conservation philosophy

186. As a general recommendation, archaeologists and cultural resource managers are encouraged to work actively to develop a preservation/conservation philosophy. Lipe's (1974) conservation model marks an excellent point of beginning for the development of such a philosophy. The American Society for Conservation Archaeology is made up largely of members of the Society for American Archaeology, although not all members of the latter are members of the former. When that happens, the archaeological profession in the United States will have developed a conservation philosophy. It is hoped that the efforts compiled in this report will encourage professional participation by all archaeologists and cultural resource managers in regional and national conservation organizations.

Education

187. As Lipe (1974) so cogently points out, conservation of the Nation's cultural resources will only be successful when a broad segment of the population is made aware of the value of the remains of our heritage. The task of conveying an appreciation of the value of our archaeological resources must be approached from a variety of directions, particularly in regard to the protection and ultimate preservation of sites and the data they contain.

188. A primary focus of this initial statement is to provide Federal land managers with guidance in site preservation. If land managers are to be successful in protecting archaeological sites from destruction by the general public, it will be necessary to educate the public about the value of the resource as well as the legal ramifications of destroying or disturbing Federally held resources. Under 18 U.S.C. Section 1361, anyone who is found guilty can be sentenced up to a $10,000 fine and/or 10-year imprisonment. The penalty is plainly severe, but most Federal employees seem unaware of the statute. That the laws protecting cultural properties apply equally to agencies as well as individuals is evidenced by the recently filed suit against Region 3 of the US Forest Service. One would suspect that resource management education, including familiarization with applicable statutes and regulations, must begin at the upper level of management and proceed to blue-collar levels in an orderly manner. This is not meant as an indictment of any or all land managers other than to point out their ignorance of statutory requirements. A common-sense approach to resource management will allow an agency to work

within the parameters of fiscal constraints as well as within the letter and spirit of the law.

189. When it becomes clear to the general population that an agency's employees will comply with the regulations that protect our archaeological heritage, the former is much more likely to respect and protect our heritage also. If a state trooper or highway patrol officer is seen speeding with no emergency lights or siren in evidence, how many of the rest of us are likely to want to stay within the legal speed limit?

190. It is recommended that every Federal land managing agency institute a lay program of archaeological resource instruction. For example, the US Forest Service in Mississippi organized a 3-day seminar in 1978 precisely for that purpose (Wynn 1978). Other such seminars are organized periodically by the Bureau of Land Management, the National Park Service, and other Federal agencies to sensitize their employees. Care should be exercised during the planning of such training sessions to ensure that all participants are made aware of their responsibilities and obligations under the law. They must also be made aware that the general public will be expected to adhere to these requirements.

191. Education of the general public is a much harder task but can be approached in both a formal and an informal manner. Formally, lectures can be organized, and agency archaeologists can offer to make presentations in public schools. Many municipal recreation departments offer evening leisure classes which can provide another teaching forum. Agency archaeologists can also offer to make presentations to civic clubs, scouts, garden and book clubs, and anyone else who will listen. The logic for such an approach can be seen in the analogy that follows:

> Imagine a historian in a room in the National Archives, which is crammed with unstudied original documents of all dates, being told, you may select only one of these documents, without opening it, for study. The historian makes his agonizing selection on the basis of his experience--on superficial appearance, the quality of the parchment, a glimpse of a word or two--and then stands back while the rest is systematically thrown into a fire. He may be allowed to rake through the ashes to see if anything is left, but all the time he knows that in every room in the building similar fires are being fed with similar irreplaceable data. This is precisely what is happening to our archaeological record of man's heritage.

Federal agency archaeologists are not singled out to bear the burden for public education since it is the responsibility of all professionals.

192. Small interpretive parks that require minimum maintenance, with signs that explain what a resource is and why it should be left undisturbed, are effective means of educating the reading audience. Obviously, a commonsense approach to park development is necessary, both with regard to site selection as well as the message to be conveyed by signs.

Evaluation of preservation

193. As noted earlier, few efforts are made to follow up on preservation projects once they are completed and appear to be successful. When regular monitoring does occur, no easily accessible reports of success or failure of the effort are presented in the literature.

194. Because of our general ignorance about the effects of preservation efforts on archaeological elements, we are still at the stage of basic data collection. Standard streambank stabilization techniques will no doubt work fine on some archaeological sites, but no attempt has been made to determine fully the impact of such techniques on the site components. Similarly, the protective needs of an archaeological property may exceed those that can be derived through conventional stabilization efforts.

195. A number of efforts to preserve archaeological properties have been put into place, but no reported evaluations are available. It is recommended that a broad sample of these efforts be selected, the person(s) or agency responsible for installing the technique contacted, and the sites visited. The archaeologist responsible for installing the protective measure should visit the site with the Corps archaeologist and explain what was done, why, what considerations were given to the measures to be put in place, and what negative impacts were anticipated. The appropriateness of the technique should be judged and observations recorded. These conversations and observations should lead to the generation of test procedures that could be applied to a site prior to the initiation of a preservation measure. They should also lead to the development of a scale for judging success.

Determinants for site preservation

196. None of the processes identified here are inexpensive. However, expense must be calculated for the long term rather than the short term and the value of the preserved data judged against the cost.

197. Obviously, not all sites can or should be protected and preserved. Attention should be given to the generation of criteria that would allow a decision to be made concerning what sites to save. Eligibility for the National Register of Historic Places is merely a beginning, a means of narrowing the universe of sites that might be considered. The emphasis of the much-touted National Park Service "state plan" (required by the NHPA 1980 amendments) on regionally significant research needs is virtually useless at this juncture, but could ultimately provide the necessary evaluation criteria. In October 1984, only five States had an acceptable plan, and few others had even begun to draft such a research and preservation document. A series of regional working meetings to be attended by invited participants might be effective. Such workshops could be patterned after the Society for American Archaeology-sponsored Cultural Resource Management Archaeology meetings held across the Nation during the fall of 1984.

Technical advisors

198. In discussions with Federal agency archaeologists during this study, they gave the impression that a manual on site preservation for use by nonarchaeological managers was premature. These individuals also felt that the present state of the art in site preservation was too poorly understood and developed to justify independent experimentation without benefit of broad-ranging advice.

199. One solution to this problem would be for the Corps of Engineers to establish an advisory board to assist the Corps in technical matters relevant to site preservation. This board should be made up of archaeologists who have direct experience in site management through preservation. They should also be drawn from across the United States. Division archaeologists might be appropriate as advisors, but they should be given the opportunity to identify others with more experience if they feel it necessary. One or two advisors should be selected from outside the Corps to add balance to the board.

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APPENDIX A: QUESTIONNAIRE SURVEY

Description

1. The prime purpose of this study was to develop the first edition of a guide for archaeological site preservation. A secondary function was to evaluate the extent to which contemporary archaeologists are involved in such projects. It was determined that the most appropriate method of eliciting information concerning site preservation activities was through the use of a brief questionnaire. Such an instrument was devised and initially sent out from the US Army Engineer Waterways Experiment Station (WES) in Vicksburg, Miss. In consultation with WES representatives, it was determined that the initial mailing of the questionnaire would be to Federal agency archaeologists or cultural resource managers. Not all questionnaires were mailed directly to the respondents. In the case of the US Forest Service, the questionnaire was distributed through their electronic bulletin board. For other agencies, questionnaires were sent in packet form to supervisory personnel, who distributed them to the individuals who ultimately composed the responses. Additional questionnaires were mailed to resource managers and archaeologists who were identified by the respondents to the initial mailing. The questionnaire is reproduced later in this appendix.

2. The questions were intentionally broad in scope but sufficiently detailed to provide information that would indicate who was active in site preservation efforts and what techniques were being used to save sites. Initially, 433 questionnaires were sent out for individual responses. Of that number, 162 (37 percent) were returned. As noted above, additional questionnaires were mailed as a direct response to receipt of the initial set. Of these, 35 forms were mailed and 9 (26 percent) were returned. Table A1 presents the distribution of the questionnaires and the corresponding rates of response.

Table A1

Distribution of Questionnaires and Corresponding Rate of Response

Questionnaire Recipient	Number of Questionnaires	Number of Responses	Return Percentage
Bureau of Land Management	120	47	39.1
State highway departments	37	17	45.9
Corps of Engineers	36	19	52.7
Bureau of Indian Affairs	9	3	33.3
Soil Conservation Service	65	44	67.6
National Park Service	110	20	18.1
US Forest Service	56	1	1.7
Miscellaneous State agencies and individuals	35	22	62.8
Total	468	173	36.9

3. Generally speaking, we did not expect a 50-percent return of our questionnaires from any single agency and were encouraged with the rate of response from the Corps and SCS. The Corps response may have been stimulated by requests and conversations held at the 1985 Society for American Archaeology meetings in Denver. We had hoped for a higher total response since we indicated in our cover letter that we were as interested in who was not involved in preservation as who or what agency or office was. The rate of [illegible] involvement of respondents was the greatest for the SCS.

4. Since we had intentionally structured the questions broadly, they could be answered with a wide variety of information. This project, by definition, was limited to the consideration of archaeological sites, and standing structures were excluded even if prehistoric in origin. The information that we received on standing structures is irrelevant to this project but may be useful in the future.

5. The first question requested each respondent to indicate whether [illegible] in archaeological site preservation. Of the [illegible] responses, [illegible] percent reported that they had been so [illegible]. This is a misleading statistic and may not accurately reflect the [illegible] involvement in site preservation, since a number

of the respondents are not archaeologists. In particular, the SCS has a very limited professional archaeology staff, and the majority of their cultural resource managers are professionals in other areas (e.g., biology). We assume, therefore, that their answers reflect work done by their offices since they are not expected to have done much archaeological work themselves. In other instances, we received responses indicating that the individual had experience in site preservation, but not while they were in their present job. Some respondents were not currently in a job that would provide them with the opportunity to be actively and personally involved in site preservation.

6. We were encouraged that over 50 percent of our respondents have been involved in site preservation, but we do not feel that this rate of participation in conservation projects holds for the total practicing profession. Our sample is probably badly skewed from the perspective of the total profession since our contacts were largely with people who would predictably be involved in site conservation.

7. In some ways, the responses that we received for the second question were the most discouraging. A common point made in many of the responses was that most preservation projects are not written up in an easily accessible form. The question has the potential for providing an overview of what techniques are being employed to preserve archaeological sites. At the same time, this response helps produce a bibliographic summary of in-place preservation attempts. Responses to this question did identify a wide variety of suitable procedures. Throughout this and earlier research, one of our main difficulties in assessing preservation efforts has been in identifying reference material. Face-to-face contact and communication between professionals appears to be the most reliable means of information exchange.

8. The lack of a developing series of preservation case histories can be only partially attributed to the professionals involved. In some of the reported cases, professional archaeologists appear to have been involved as consultants only; in other instances, the source of funds effectively dictates that no accessible report will be made available for professional use. We have the impression that often under such circumstances no report is required for specific agency use either.

9. The survey respondents identified 50 techniques, which are listed separately following the questionnaire. Some of the suggested techniques are [illegible] region-specific (e.g., snow fencing), but many can be adapted for use

in a broad range of environments. The most frequently used techniques for archaeological properties were: (a) earth burial - 17 examples; (b) riprap covering - 17; (c) site avoidance - 15 (considered site preservation by respondents but not the authors); (d) site fencing - 14; and (e) sodding - 7.

10. It quickly became apparent that only a very small number of the reported instances of site preservation were being regularly monitored to ascertain the effectiveness of the technique or its effects on the archaeological property. At this stage of our developing knowledge, we must take every opportunity to study the effects of the procedures on the cultural remains. In so far as the traditional usefulness of most preservation techniques is concerned, little additional study would appear necessary. For example, the effectiveness of riprap as a streambank stabilizing technique has been demonstrated, but the effects of the weight of riprap on archaeological site elements remains to be ascertained. Similar statements can be made for most of the site control measures that are reported here. The questionnaire did not request comments on monitoring, but since continuous control is such a vital part of site maintenance, we expected that some mention of monitoring procedures would be included by the respondents. However, very few comments were received.

11. The lack of monitoring is apparently due to fiscal constraints. We hope that as site preservation and conservation are practiced more frequently, better organization of the effort will result in regular visitations to ensure conservation success. Successful prosecution of acts of vandalism will support and encourage resource managers and agency fiscal officers who must justify their yearly requests for monitoring and maintenance funds.

12. Virtually none of the reported preservative techniques appear to be inexpensive, and they appear to have been carried out with funds that were already on hand. As a direct consequence, when [illegible] the reported [illegible] is tried in the future, it should not be viewed as a temporary measure [illegible] any applications of these techniques are [illegible] sense, they should be carefully thought [illegible]

13. Question [illegible] was designed to help [illegible] sible who have been involved in site [illegible] the initial mailing. We were [illegible] names reported to us. We [illegible]

each of the referrals, but in the final analysis, only 35 questionnaires were mailed to this group with a 25.7-percent rate of return.

14. While the number of referrals appears to be relatively low, more people are involved in site preservation than we had initially thought. Unfortunately, this larger number than anticipated also suggests that more is being done but simultaneously less is being entered into the professional record.

15. Most professional archaeologists can immediately draw up a list of at least a dozen ways that sites are destroyed or damaged. We realized that numerous forces were acting to destroy archaeological properties, but in spite of prior research, we felt that our knowledge was largely reflective of the southeastern United States.

16. Question 4 was intended to give us some insight into the magnitude of site destruction on a national level and, where possible, to advise us concerning how individual problems had been resolved. Responses to this question are listed at the conclusion of this appendix. Vandalism and various kinds of erosion are viewed as the main forces acting to destroy archaeological sites. As one might expect, the situation is generally more complex than the listing suggests. Forces that may be viewed as being of natural origin are aided and abetted by culturally produced or induced factors. For example, the rate of sheet erosion is increased as a direct consequence of cultivation.

17. Most of us view vandalism as an intentional act of destruction, but strictly speaking, acts of vandalism can also occur as a result of ignorance on the part of the perpetrator. While both kinds of acts are extremely difficult to counter, it seems that willful destruction can best be curtailed through prosecution while ignorance can be dealt with through the education process.

18. Vandalism of either kind is not predictable in the same way that natural phenomena are and, as a result, moments of desecration cannot be pre[illegible] sites that are especially [illegible] respond to the dictates of a [illegible] movements and their [illegible] predictable [illegible]. The same can be said [illegible].

19. [illegible] ways that sites are [illegible]

report. However, they were included to ensure that the breadth of the cultural resource loss is fully appreciated.

Sample Questionnaire

1. Have you personally been involved with an archaeological site stabilization effort, Yes___ No___

2. If your answer above was yes, briefly describe the effort, indicating the kind of site (mound, etc.), the kind of stabilization technique that was applied, when the effort took place, and where it was written up. If copies are available, please indicate the source.

3. If you know of anyone who has been directly involved in site preservation, please provide his name and address so that we may contact him. Please keep in mind that we are interested in anyone who has undertaken stabilization efforts, not just professional archaeologists.

4. We generally recognize two broadly defined forces which lead to site destruction natural (riverine and lacustrine wave action, erosion, etc.) and

culturally promoted (vandalism, pot hunting, logging, etc.). On the basis of your personal knowledge, list as many forms of site destruction as possible. We are interested in knowing about forces operating in your research universe, even though they may not occur anywhere else. How have you solved or attempted to solve these unique problems? Please keep in mind that our present effort is baseline and we would appreciate knowing about the most mundane of efforts.

Responses to Question 2

	Methods of Site Stabilization	No. of Times Mentioned
1.	Earth burial	17
2.	Riprap	17
3.	Avoidance	15
4.	Site fencing	14
5.	Sodding	7
6.	Repointing walls or bricks	7
7.	Standing structure stabilization	6
8.	Site reconstruction	5
9.	Soil cement	5
10.	Signing sites	4
11.	Concrete slab	3
12.	Gunite	3
13.	Snow fencing	2
14.	Graveled over site	2
15.	Tunnel filled with sand	2
16.	Steel piling	2
17.	Deadfalls	1
18.	Trilock blocks	1
19.	Channelization/dredged material placement	1
20.	Dike	1
21.	Rock berm	1
22.	Sand burial	1
23.	Rock and boulder covering	1
24.	Ceremonial and burial site statutes	1
25.	Filter cloth and I-beams	1
26.	Site (resource) relocation	1
27.	Pargeting with compatible material	1
28.	Dry-laid masonry walls	1
29.	Gravel burial	1
30.	Concrete block mat	1
31.	Pencapsula	1

Methods of Site Stabilization	No. of Times Mentioned
32. Silicone, tung oil, water glass	1
33. Hydrozo	1
34. GEOWEB	1
35. Deed attachment for National Register properties	1
36. Move all or part of building	1
37. Use part of National Register building	1
38. Rhoplexe 330 with water and silty or clayey sand	1
39. Wooden retaining wall and fill	1
40. Log revetment	1
41. Backfilling with sterile material	1
42. Backfilling with soil from hole	2
43. Decreased moisture seeping into cliff	1
44. Cement caps on walls	1
45. Vehicle barricades	1
46. Diversion of water	1
47. Buried wire mesh	1
48. Patrolling	1
49. Cement veneer with cement wall in front of site	1
50. Adobe stabilization	1

Responses to Question 4

Methods of Site Destruction	No. of Times Mentioned
Construction	9
Modern construction	14
Road construction	15
Dam construction	5
Sewage lagoon construction	3
Building site preparation	6
Agricultural practices	9
Cultivation	7
Irrigation	2
Terracing	6
Haying/grazing	10
Pond building	3
Land leveling	10
Chisel plowing	5
Field expansion	1
Sod busting	1
Alluviation	2
Artifact collecting	2
Acid rain	1
Bioturbation	5
Burrowing bivalves	1
Bridge rebuilding	[illegible]
Burning	[illegible]
Climate	[illegible]
Clam digging	[illegible]
Civilian target practice	[illegible]
Cumulative effects of pot hunters	[illegible]
Compaction	[illegible]

Methods of Site Destruction	No. of Times Mentioned
Clearing pasture	1
Catfish ponds	1
Clearing and grading	2
Chaining brush	4
Coal loading facilities	1
Dredged material placement	2
Dredging	4
Dogs	1
Destruction of house floors	1
Drainage ditches	3
Deforestation	2
Dikes	1
Erosion	
Sheet erosion	25
Wind erosion	33
Tidal erosion	23
Barge and boat traffic	17
Earthquakes	4
Exfoliation of rock art	4
Erosion control	1
Fencing	1
Flooding	5
Forest fire	10
Frost heave	15
Gravel quarrying	6
Gullying	6
Golf course development	1

Methods of Site Destruction	No. of Times Mentioned
Heavy equipment	4
High-water levels in Great Lakes	1
Hurricanes	1
Ice heaving on Mississippi River	1
Isostatic and eustatic phenomena	1
Ice pack	1
Inundation cycles	11
Improper archaeological excavation	5
Ice scouring	1
Logging	7
Lime deposits in caves	3
Living history reenactments	1
Levee construction	1
Levee crevasses	1
Levee setbacks across natural levees	1
Levees used for borrow	2
Landfills	1
Mud and land slides	2
Military firing ranges	4
Men urinating on rock art	1
Metal detectors	4
Military exercises	3
Oil field development	6
Off road vehicles	22
Pipelines	3
Poor onsite drainage	1
Precipitation	1
Precipitate excavation (mining)	1
Perched water table	1

Methods of Site Destruction	No. of Times Mentioned
Rangeland to cropland	2
Reservoir modification	1
Rodent and insect disturbance	7
Root plowing	1
Recreation	12
Rock art used for target practice	2
Rock art theft	1
Rockfall	1
Road maintenance	2
Revetment construction	1
Rock art used as scratching post	4
Range improvements	2
Sand quarrying	5
Strip mining	16
Sedimentation	1
Submerged resource erosion	1
Saltwater	1
Swamping out	1
Sonic vibrations	3
Saturation	1
Subsidence	1
Sand blows in midden	1
Shipwreck salvors	1
Seismic equipment and blasting	3
Salt erosion of adobe	1
Trampling	28
Timber clearcutting	[illegible]
Tourists rebuilding walls	[illegible]
Talus erosion	[illegible]
Urban expansion	[illegible]
Uncontrolled visitation	[illegible]

Methods of Site Destruction	No. of Times Mentioned
Vandalism	54
Volcanos	1
Wild animals	11
Water action through walls	3

END
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